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VOLUME 3, No. 11 NOVEMBER 1951

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WORLD CROPS

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VOL. 3 No. 11 NOVEMBER 1951

CONTENTS

EDITORIAL COMMENT:
West African Cocoa; The Outlook for Cocoa; Soviet Science; Leguminous Crops and Fertility; Cortisone from Sisal Waste; Once More—the Ant; Catalogues of Genetic Stocks 415

The 1951 Cocoa Conference 419

A Mediterranean Survey—*R. O. Whyte*, PH.D., B.SC. 425

Biological Control of Insect Pests on Crops—*R. J. A. W. Lever* 430

Correspondence 432

Improvements in DDT Spraying—*G. A. Emery*, M.A. 433

The European Farm Machinery Situation 436

The Future of FAO 440

Recent Advances in Locust Research—*B. P. Uvarov*, C.M.G., F.R.S. 441

Cotton Research in the British Commonwealth ... 445

Virus Control of Australian Rabbits—*T. A. G. Hungerford* 447

Experimental Agriculture, Part I—*Dr. E. M. Crowther* 448

New Books 451

Our Second Anniversary 452

Research Developments 454

Factors Affecting Rice Production 456

Farm Machinery: American Rotary; New IH Combine; Fineness Tester on a New Principle; Combined Car and Tractor Introduced in Italy 457

World Crop Reports 459

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SOME PROBLEMS OF CROP PROTECTION IN WORLD AGRICULTURE

THAT IS THE TITLE OF an International Agricultural Conference which was held at the Fernhurst Research Station of Plant Protection Ltd., from 25th to 28th June, 1951, and attended by delegates from thirty-nine nations.

A report of the proceedings of this Conference, including the papers which were read and the lively discussions which they provoked is being produced for the Delegates. A limited number of copies of this report will be available for sale. If you would like more information please write to:

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Editorial Comment

West African cocoa

THE recent cocoa conference, an account of which appears on another page, was productive of up-to-date information concerning the general position of the cocoa industry, and in particular of events in West Africa, the largest producing area in the world, where for some years cocoa orchards have been threatened by the complex of virus diseases known popularly as ' swollen shoot.'

There is no known remedy for it; the only palliative is the drastic measure of cutting out infected trees and those immediately in contact with them which, it has been shown, if rigorously pursued under appropriate conditions can check further spread. However, it has also been shown that even cutting out is powerless to control the disease if infections are massive. It is only when the infections are relatively isolated that cutting out and replantation can be an effective check.

The discovery of the new insecticide Hannane, as a result of the researches of the workers of Pest Control Ltd., has, however, altered the outlook since it gives promise of being able to kill the mealy bug vectors of the disease, without affecting the parasites and predators which attack them or causing the cocoa to become toxic. Moreover, it has been found that in other countries a number of parasites of the mealy bugs exist and the experiment is being made of introducing these in large numbers into the Gold Coast. It is too early, however, to say what effect they will have.

In earlier years, when the Colony was under Colonial Office control, policy in relation to the disease showed wide variations. A compulsory cutting out campaign was instituted, and then suspended because of popular opposition, pending a visit from three non-British scientists selected by FAO. These confirmed earlier findings and recommended the immediate resumption of compulsory cutting out as the only practicable remedy. The government accordingly instituted a new compulsory cutting out campaign, and set up a special department to deal with it in the heavily infected areas, controlled, not by the agricultural authorities, but by administrative officers—yet another instance of the touching belief of officialdom that in the last resort there is really nothing to equal the non-technical civil servant when it comes to handling difficult administrative problems bristling with technicalities.

With the advent of responsible self-government in the Gold Coast has come yet another change of policy. At the conference this was expounded by Mr. Casely Hayford, Minister of Agriculture in the new Gold Coast Government. Briefly, it depends on the cessation of compulsory cutting out, and the vigorous prosecution of voluntary cutting out, with compensation for destroyed trees and grants for replantation, combined with the intensive use of the new insecticide Hannane, on a wide scale in lightly infected areas, provided subsequent tests confirm earlier findings.

The mass infected areas will be isolated by a cordon sanitair to prevent further outward massive spread of the disease. Inside this the disease will be allowed to take its course and the rehabilitation of the most productive lands undertaken as soon as conditions permit. The Department for Swollen Shoot Control in the special areas has been abolished and the whole of the operations placed once more under the Agricultural Department.

Mr. Casely Hayford explained that there was widespread acquiescence and popular support for the new policy, although one cannot help wondering whether the Gold Coast Government are entirely wise in abrogating altogether compulsory powers which could in the last resort be used in dealing with a recalcitrant minority.

No one, however, who listened to Mr. Casely Hayford's speech could fail to be impressed with his obvious sincerity, his clear grasp of the essentials of the problem and his realistic approach to it. He obviously fully apprehended the dangers, and did not allow his judgment to be deflected by the fact that during the last couple of years they have been to some extent masked by increasing yields from new plantings.

The outlook for cocoa

FOR the dangers are real enough, not only in the Gold Coast itself but also in the adjacent territory of the Ivory Coast in French West Africa, where considerable areas are affected with the most virulent form of the disease. We are told that the ' usual measures ' are being taken there to control it, but no details are forthcoming of their form, or the exact extent of the area affected. It seems, however, that the position is serious and in any event the menace is not confined to the Ivory Coast alone, but also constitutes a flank threat to the Gold Coast itself. There seems to be a clear case for close international collaboration in control measures.

Swollen shoot also exists in Nigeria although in a somewhat less virulent form which makes control more difficult, since the death of an infected tree may not occur until several years after infection is discovered. The Nigerian Government have experimented with compulsory cutting out, but have also been forced to abandon it after four years' experi-

ence, and to rely on a campaign of isolating mass infected areas to prevent mass outward spread, and concentrating on establishing new and better tended plantations in areas at present uninfected.

We can only hope that the measures now being taken or which will be taken in the immediate future will ultimately succeed in stemming the ever rising tide of infection. The prevailing note in the Gold Coast at present is one of restrained optimism, but it seems essential that the authorities should not allow themselves to be lulled into an outlook of false security.

Meantime, it is not surprising that increasing attention is being paid to the possibility of developing and extending cocoa growing in other parts of the world where the serious diseases prevailing in West Africa and South America do not exist. Cocoa has long been cultivated on a limited scale in Ceylon and Java and lately expeditions financed by one firm of cocoa manufacturers have made clear that there is abundant land climatically suited to cocoa in South-East Asia and in the islands in the South Seas, notably New Guinea and the Solomon Islands. Fairly extensive developments are already taking place in Malaya which have been described in a previous number of WORLD CROPS, and, under the stimulus of an increasing demand and uncertainty as to the future, other developments seem likely. The main point seems to be to ensure that they should take place on ordered lines, with due precautions and adequate provision of scientific services, avoiding, so far as possible, the haphazard and unplanned expansion of planting which has characterised developments in the past and which, it may be emphasised, in reality lies at the root of so much of the present trouble.

Soviet science

STIMULATED no doubt by the historic directive of Mr. Stalin to Soviet scientists ' rapidly to overtake and surpass the achievements of scientists in other countries,' the world has become accustomed to the periodic emergence from behind the iron curtain of alleged discoveries and points of view which challenge accepted theory and the findings of science, especially biologic science, in the Western world. Usually these are accompanied by disparaging remarks about the competence of Western workers who, it is suggested, are enslaved by bourgeois outlooks, although why a bourgeois outlook should render a worker incapable of sound scientific work is not entirely clear. It is one of the mysteries of dialectical materialism apparently.

A classical example is the great Lysenko controversy which continues to rage with unabated fury. Probably inspired by it is the latest and perhaps the most startling development, which claims to have established that the long accepted view that cells can only arise by the subdivision of other cells and that life outside the cell is impossible, is erroneous.

A paper by Professor Khrushchov which recently appeared in *Pravda*, and an English translation of which appeared in *Interagra*, the journal of the Cechoslovak Institute for Collaboration in Agriculture, describes the new theory of Professor O. B. Lepinhinskaya, of Leningrad University, which claims to have discovered that living cells can originate from undifferentiated organic matter such as the yolks of eggs, which are held to be non-cellular living substance.

A further development on similar lines is the reported discovery by Professor G. M. Boshyan of the Institute of Experimental Veterinary Medicine at Moscow that under certain conditions filtrable viruses can change into microbial forms and *vice versa*. He and his co-workers apparently worked upon the virus of infective horse anaemia, and they state that discoveries made in 1946-47 enabled them to obtain the causative virus in the form of microbes visible under the microscope.

From this they proceed to the deduction that viruses are nothing but particles of living matter capable of growth, reproduction and metabolism, and that under certain conditions it is possible to change filtrable viruses into microbial forms and *vice versa*. The microbes which are formed are polymorphous and ' dissociable ' in the widest sense; their formability and the speed with which they change from one form to another are unequalled.

This is all very startling. The various assertions are not accompanied in the accounts we have seen by any experimental evidence; they are, however, lavishly decorated by unfavourable comments on the work of earlier authorities such as Pasteur, Wirchow, Koch and Ehrlich, which, it is claimed, is beclouded by metaphysical dogmas. It would be easy to retort that dogmatic assertions do not appear to be entirely absent from the claims of the Soviet scientists, although this does not get us any forrarder. It is probably wiser to maintain in the absence of more detailed information an open mind, and to hope that in due course detailed results will be forthcoming which will enable the conclusions of the Soviet scientists to be tested independently. One deduction may, however, be made legitimately, *viz.*, that scientific research and political propaganda do not make good bedfellows.

Leguminous crops and fertility

MORE and more is attention being directed towards the use of leguminous crops in the maintenance and restoration of soil fertility, and as a constituent of animal fodder. It is, of course, no new thing; the value of such plants as soil improvers was known to the ancient Romans and the use of lupins in this connection was mentioned by Virgil in the Georgics.

Their mode of action was, however, not elucidated until the eighties of last century when Helreigel and Wilfarth demonstrated the action of symbiotic bacteria in fixing atmospheric nitrogen.

Their growth as a cover crop followed by their bedding in as green manure is an old practice. It has given on the whole excellent results, more especially in temperate climates; under tropical and sub-tropical conditions results have been more variable.

It is, however, in connection with the use of legumes as components of grass leys that the most noteworthy results have been recorded of late. The importance and value of grass leys as components of arable rotations is now well recognised both in temperate countries and in the tropics. Their value is greatly enhanced by the inclusion of leguminous plants therein, the various kinds of clover being predominant. In temperate and semi-temperate countries they are widely used, but under tropical and sub-tropical countries there is as yet no fully adequate substitute for clover available.

The need for this is considerable and increasing attention is being paid to the question. There are a number of indigenous clovers occurring in the higher parts of East Africa and it does not seem beyond the bounds of possibility that from them varieties suited to tropical conditions might be produced. Alfalfa (*Medicago sativa*) has been suggested as a substitute and experiments with it have been tried with some success in Palestine. More promising are the so-called burr clovers of the Eastern Mediterranean region, which are themselves species of *Medicago*.

The fodder resource survey recently initiated by FAO and OEEC in the Mediterranean region (an account of which appears in this issue) has thrown the matter into some prominence and it seems likely that some trade in the seeds of leguminous pasture plants may arise in the near future.

In this connection we may call attention to a point raised by a correspondent in our previous issue in which he stressed the disturbing lack of knowledge of leguminous plants suitable to the Mediterranean area and suggested the establishment in England under glasshouse conditions of a collection of leguminous plants. He suggested that a suitable venue might be at the Royal Gardens, Kew, and stressed the point that the collection should be under the care of a responsible and recognised authority. The point seems to us to be worthy of attention and we commend it for consideration by the authorities at Kew and the Commonwealth Agricultural Bureaux.

In the same connection we gather that FAO have embarked upon the production of a comprehensive monograph on the subject of leguminous crops for fodder and for the improvement of soil fertility. Such a compilation should be invaluable, having view of the paucity of collected information on this important subject.

Cortisone from sisal waste

OF the recent medical discoveries none has excited more interest than that of cortisone, the compound which has been found to possess remarkable curative properties for rheumatoid arthritis, that scourge which takes so terrible a toll at present. Its discovery has brought a new message of hope to thousands of crippled sufferers from this dread disease.

Until recently its preparation has only been effected from the bile acids, involving the handling of large amounts of material for the recovery of small quantities of the product. It is therefore scarce and expensive, which places it beyond the reach of many sufferers.

Latterly, the possibility of using steroidal sapogens derived from vegetable materials as a possible first stage for the preparation of the product has attracted much attention.

A recent note in *Chemistry and Industry* by Messrs. Callow, Cornforth and Spensley of the British National Institute for Medical Research places on record that a compound of this group, Hecogenin, has been found to be comparable with the bile acids as a starting point for the synthesis of cortisone. It was first found by Marker and his co-workers in the U.S.A. in various species of American Agaves. They did not however investigate *Agave sisalana*, the source of commercial sisal, which is extensively cultivated in East Africa.

As part of a scheme of research initiated by the British Medical Research Council this plant has now been investigated and the leaves found to contain Hecogenin, which can be readily extracted. More important from the point of possible commercial production is the fact that it can be extracted from sisal waste consisting of short fibres and connective tissue which is produced in large quantities in the separation of the commercial fibre. The disposal of this waste has for long been a problem, and various processes have been proposed for its commercial utilisation. They have included the preparation of pectin for use in jam making and the use of the material as a stabiliser in earth road construction (see WORLD CROPS, Vol. 1, p. 69).

The authors of the note state that a process of extracting Hecogenin from sisal has been worked out on both a laboratory and a pilot plant scale.

If this promise is fulfilled it may well bring relief to many sufferers while at the same time opening up a profitable means of utilising a waste product of the sisal industry.

Once more—the ant

WE hope we shall be forgiven for once more reverting to the subject of ants and not be accused of having ants on the brain if not in our nether garments.

The immediate cause of this remark is a recent letter to our contemporary, *Nature*, from Mr. M. J. Way, an entomologist attached to Rothamsted Experiment Station, who was recently seconded to work on clove research in Zanzibar in connection with the suspected transference of sudden death disease of clove trees by scale insects attended by ants.

Mr. Way records that for years severe losses have been experienced in Zanzibar from the premature fall of unripe coconuts, formerly attributed to unsuitable soil conditions, but now shown to be due to a coreid bug *Theraptus sp.* which punctures the calyx of female flowers and penetrates the young fruit.

The damage appears to be similar to that previously reported from the Solomon Islands as being caused by *Amblypelta cocophaga* (referred to in these pages, Vol. 11, p. 3). In that case the insect was reported to be controlled by the ant *Oecophylla smaragdigna* and now from Zanzibar Mr. Way records that when another species of *Oecophylla* (*O. longinoda*) is present in the trees the damage from coreid bugs is negligible.

In many areas in Zanzibar, however, Oecophylla has been replaced by certain ground-nesting but tree-inhabiting ant species, including a species of Pheidole, another species of which was reported to be hostile to Oecophylla in the Solomons. However, Mr. Way reports that Pheidole is not aggressively active against Oecophylla in Zanzibar. Nevertheless, the general parallelism between the occurrences in these two far-removed places is striking, and more than ever does it seem apparent that we should consider the ant and its activities very carefully.

Mr. Way also reminds us that as long ago as the 12th century a species of Oecophylla was apparently used as a beneficial predator on citrus pests in China, a point which is also mentioned in an article on biological control of insect pests by Mr. R. J. A. W. Lever in this issue. It all goes to show that there is nothing new under the sun and it also shows how carefully we should heed the advice given by Solomon to consider the ant.

For the economic importance of ants is becoming more and more manifest. Let us bear in mind the Brazilian saying that 'Brazil must destroy the ant or the ant will destroy her', and although perhaps the position in this regard is not serious in other parts of the world and many ants are beneficial in their activities, it is obviously desirable that we should know as much about them as possible.

The recent publication of G. E. J. Nixon's monograph has provided a useful summary of existing information on ant associations with coccids, and it seems highly desirable that research on the whole relationships of ants should be taken in hand.

The Colonial Agricultural Research Committee, the last report of which we review on another page, has shown its activity in stimulating research on parallel questions such as Termites and Arthropoda in the Soil, and we venture to suggest that ant activities in relation to agriculture in the tropics might suitably form the subject for another comprehensive research scheme when opportunity offers.

Catalogues of genetic stocks

THE rapidly increasing skill of the plant breeder makes possible achievements which were undreamt of a generation ago. By modern breeding methods it is now possible to transfer characters from one variety of a cultivated crop to another and so to evolve new strains possessing desirable properties. Particularly important is resistance to various pests and diseases and many examples could be cited of disease-resistant strains of cultivated crops which have been evolved by the plant breeder.

To assist work of this character it is obviously desirable that plant breeders should have available full information concerning existing strains of crops, their characters and their availability. Accordingly the inauguration by FAO of a series of catalogues of breeding stocks for a number of crops is an important step forward. It is, of course, a labour of herculean proportions which must continue for an indefinite period, having regard to the number of crops involved and to the fact that as the work is continued new and hitherto unknown strains are certain to continue to come to light. A beginning has been made with the cereals and so far two catalogues and two supplements have been issued, dealing with wheat and rice respectively. The plan adopted is to circulate questionnaires to plant breeders and experiment stations in areas where the crops are grown and to transfer the resulting data to punched card indexes, thus constituting the catalogue. From these the data are reproduced in mimeographed form for the use of plant breeders the world over. In undertaking this work FAO is performing a service of inestimable value which in years to come should bear abundant fruit in the shape of ever-increasing improved crop varieties.

THIS MONTH'S COVER

A pine tree is nudged out of the ground by an International TD-9 crawler tractor equipped with an Isaacson bulldozer, during landclearing operations on 240 acres being prepared as a tung tree plantation in the southern part of the State of Mississippi.

The 1951 Cocoa Conference

Many articles have already appeared in WORLD CROPS *on the cocoa industry. The threat to production in West Africa, the West Indies and South America has attracted much attention in view of the possible consequent shortage of supplies. For some years past the position has been reviewed at annual conferences organised by the Cocoa, Chocolate and Confectionery Manufacturers' Alliance. The most recent was held last September and we reproduce below a report of this in which the present-day cocoa situation is summarised.*

THE sixth Cocoa Conference, convened by the Cocoa, Chocolate and Confectionery Alliance, was held at Grosvenor House, London, between September 11 and 13, 1951.

These conferences have become an annual feature. At them the position of the cocoa industry is reviewed from the point of view of both producers and consumers and recent research is summarised and discussed. They are thus particularly valuable, especially in view of the threat to the industry from disease, both in the American and African regions.

This conference was the largest ever held, the number attending totalling 250. Its membership included officials from cocoa-growing territories in Africa and the West Indies, research workers from the United Kingdom, as well as representatives from Belgium, Brazil, Canada, Denmark, France, Holland, India, Irish Republic, Japan, Norway, Sweden, Switzerland, U.S.A., Venezuela and Western Germany, and members of manufacturing and commercial organisations. Its representative character, therefore, needs no emphasis.

The conference can be said to have provided a complete review of most of the present features of the cocoa situation and in the following paragraphs the main points which emerged are summarised.

The conference, which held eight sessions, was opened by Mr. W. Wallace, President of the Alliance. The subjects comprised world supply and demand, research and development in the Western Hemisphere and in Africa, the quality of cocoa, cocoa disease and cocoa production in new areas.

At a luncheon held on September 12, the Hon. Mr. A. Casely Hayford, Minister of Agriculture and Natural Resources in the Gold Coast, reviewed the present situation in the Gold Coast and described the measures to combat the diseases, while at a dinner on Wednesday Mr. T. F. Cook, M.P., Parliamentary Under-Secretary for the Colonies in the United Kingdom, delivered an address.

Young cacao establishing itself in partially thinned jungle, Malaya

Cacao and rubber growing together in the same plantation in Ceylon

Supply and demand

Mr. L. A. Byles discussed the trend of production and consumption of raw cocoa, and traced the course of events during the past 50 years, pointing out that in that period a revolution in production had occurred.

A hundred years ago world production of cocoa was only 16,500 tons; in 1900 it had grown to 100,000 tons p.a., and by 1938-39 an all-time record of 787,000 tons was achieved. After 1939 the upward trend was reversed and output fell steadily till 1944, when only 544,000 tons were produced.

Subsequently, an equally quick recovery set in which has lasted until the present time. The estimated crop for 1949-50 was 754,000 tons, and that of 1951 768,000 tons. Thus we are within measurable distance of the record crop of 1938.

So far as concerns consumption, the trend has been more variable. Consumption is largely concentrated in a few countries of the Northern Hemisphere; today the U.S.A. accounts for 46% of the total, as against 39% in 1930. Europe consumed 39% in 1930, but the percentage dropped to 32% in 1944; today it consumes about 50%.

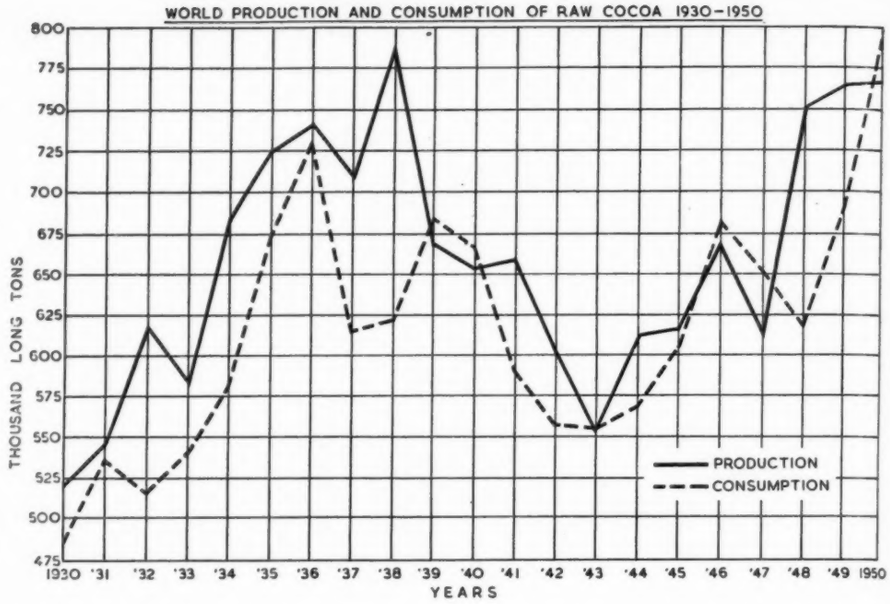
During the inter-war years production somewhat exceeded consumption and as a result stocks accumulated and prices were at a low level.

Since the war a state of rough equilibrium between production and consumption seems to have been reached, and for three years production has remained virtually unchanged. No dramatic changes in the volume of production and consumption, or in the pattern of trade, seem likely in the near future.

It seems improbable that world output can expand at the pre-war rate for some time to come and it is uncertain if production can be expanded in the short term to catch up with the growing demand. As a result, quite small changes in either aspect may have a disproportionate effect on world markets.

Research developments

Much of the time of the conference was concerned with research developments. Mr. G. F. Bowman, chief of the Cocoa Research Centre at Turrialba, gave details of that institution. It was constituted early in 1947 as a result of action by the inter-American Technical Cocoa Committee. The objectives are to improve and increase cocoa production in the Western Hemisphere. Its programme includes the training of students for work in the cocoa industry and the pursuit of research. So far



the centre has trained 36 students from 14 different countries in the Western Hemisphere.

The research work so far is somewhat limited in volume; among the points studied have been the pollination of cocoa flowers, the incidence of diseases, particularly *phytophthora*, the effect of shade, pruning methods, the rehabilitation of cocoa farms, the selection of improved types of cocoa and propagation methods. In relation to the latter, budding has been found effective and economical.

Research at the ICTA

Cocoa research at the Imperial College of Tropical Agriculture was reviewed in papers by Professor C. Y. Shephard and Professor F. Hardy.

At River Estate the commercial scale plantings of the more promising clones selected by the late Dr. Pound will be completed this year. They should provide useful information on the performance of the various clones as buddings and cuttings and as fan and chupon growths. It has been possible to study in them the effects of virus infection on yield and to make valuable investigations on the susceptibility of the clones to witches broom disease.

A start was made last year on planting out 6,000 seedlings from their breeding programme. The plants originated from crosses made within the Imperial College of Tropical Agriculture selections, superior I.C.S. clones, witches broom-immune strains from the Amazon basin, Nicaraguan criollos and other types. Further breeding is being undertaken. Work has also included experiments to test stock-scion relationships.

Plant physiology investigations have included studies of methods of rooting cocoa cuttings, deficiencies of trace elements, leaf and tree injections for curbing mineral deficiencies.

Soil investigations have included the deterioration of cocoa soils in Trinidad and the effect of different types of cultivation and soil treatments on the growth of trees, while investigations on the fate of fertilisers added to cocoa soils have been started. Seven series of experiments have been laid out on River Estate to trace the interaction between atmospheric environment, soil environment and the cocoa plant. The staff of the cocoa research section of the Imperial College has been brought up to the level envisaged when the scheme was launched and it is now possible to proceed with the full programme of investigations.

The West African Cocoa Research Institute

This institute is located at Tafo in the Gold Coast and deals with problems of the industry both in the Gold Coast and Nigeria. Its work was reviewed by Mr. J. West, its Director, while the position in the Gold Coast was discussed by Mr. S. D. Ross and Mr. J. D. Broatch, respectively Director of Agriculture and Deputy Director of Agriculture.

Work at the Institute has been handicapped by lack of staff. It has never been possible to bring up its strength to the full quota of 18 workers provided for and, in consequence, to carry out the full programme. Work has been mainly centred on disease questions, particularly on swollen shoot disease. Other matters studied have included the introduction of improved varieties of cocoa and the fermentation of cocoa.

Swollen shoot

Further work has confirmed the earlier finding that where infections are light control can be effected by cutting out infected trees and those in contact with them. On the other hand, when infections are massive, cutting out is powerless to effect a cure, since the majority are doomed to die in any case. It is also clear that when previously infected land is replanted the disease can be held in check provided that new infections and contact trees are cut out as soon as they are detected.

Research on alternative hosts of swollen shoot virus has been continued. It is now clear that in the Western Province of the Gold Coast *Cola chlamydantha* carries the virus in areas where no cocoa exists and it is recommended that this tree be removed from existing and new cocoa areas. On the other hand, indications are that the transfer of virus from *Ceiba pentandra* and *Cola cordifolia* to cocoa is uncommon. Work on the destruction of these trees by arboricides, however, continues.

Systemic insecticides

The outstanding result of the past year is the discovery that control of the mealy bug vectors of swollen shoot may be possible by means of the systemic insecticide Hannane or C.R.409. This work, initiated by Pest Control Ltd. a year and a half ago, has been carried on by a team of three research workers under Dr. Hanna and is now being extended by WACRI in association with this organisation.

The experiments show that this insecticide, applied to the base of the tree and absorbed through the roots, is capable of killing the mealy bug. It is now thought that the time is ripe for the agricultural department in the Gold Coast to undertake extensive field-scale trials with it, to ascertain whether it can eradicate the disease and the minimum number of contacts which must be treated; also to confirm that it does not harm beneficial insects nor contaminate cocoa beans.

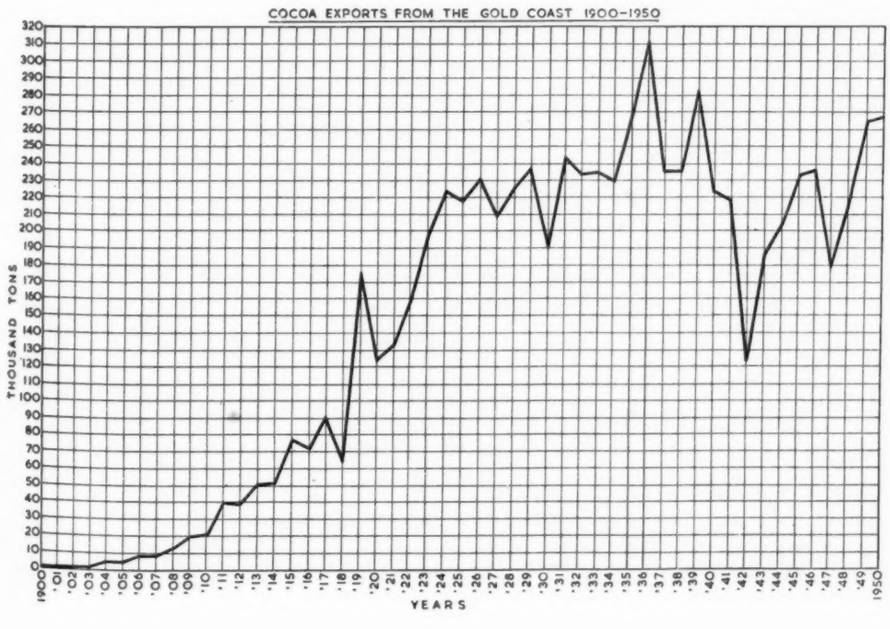
The insecticide, which is one of the organo-phosphorus group, is highly toxic and precautions in handling it are necessary. The conference was informed that a method of putting up the insecticide in capsules, which can be applied direct to the soil, was being tried. There are great hopes that this method may provide the means of controlling swollen shoot in the Gold Coast and elsewhere.

Biological control of mealy bugs

Work is also being pursued on the possibility of biological control of the mealy bug vectors. A number of parasites are known to exist and consignments of nine species have been received from California, each type being tested in the laboratory on arrival. The two most promising are *Pauridia peregrina* and *Pseudophycus angelicus*; of these, 41,559 specimens of the former and 72,066 specimens of the latter have been received and released. Recoveries have been made of the latter insect and partial establishment accomplished.

Capsid bugs

The position today held by capsid bugs remains very much where it was. Effective control of capsid and young cocoa has been accomplished by means of a solution containing DDT which is brushed on the stems of the young cocoa and controls *Distantiella theobroma*, but no effective control has yet been found for *Suklbugella singularis*, which attacks fully grown trees.



Cocoa re-establishment

The important question of re-establishing cocoa on lands previously devastated by swollen shoot was discussed in a paper by Mr. R. J. Bensted, of the West African Cocoa Research Institute. The main points are summarised below:

(1) Cocoa has been successfully established on farms previously devastated by swollen shoot disease, under a fairly wide range of environmental conditions.

(2) The most successful establishment has been on land which had either reverted to secondary bush after the cocoa died or was bearing cocoa immediately prior to planting.

(3) The effect of food farming, particularly where the cultural methods entail soil disturbance leading to loss of organic matter, is to make establishment more difficult, but not impossible.

(4) The pioneer grasses and other weeds which follow food farming can be smothered by shading with quick-growing plants, the best of which are *Gliricidia maculata* and Tree Cassava.

(5) The best type of overhead shade is composed of a number of tree species, preferably indigenous, at varying canopy levels.

(6) Cocoa can be established under existing oil palm shade.

(7) Where all cocoa has been removed prior to replanting, infection by swollen shoot disease is confined to the perimeter of the area, where infective trees exist.

(8) Spread of swollen shoot disease in young cocoa from seedling to seedling is very limited until a closed canopy has been formed.

(9) Hand painting of seedling cocoa is effective in checking the damage caused by capsids until the cocoa is too tall for this method.

Other work at the WACRI

Other work carried out by WACRI has been concerned with the improved types of cocoa. A number of imports have been made from the West Indies and South America, with the assistance of ICTA. Considerable interest is attached to species of cocoa from the Upper Amazon, which appear to have advantages over the amelonodo cocoa grown in the Gold Coast.

The cutting out campaign in the Gold Coast

The compulsory cutting out campaign for the control of swollen shoot has been stopped, following the reorganisation of the Department of Agriculture consequent on the changes in the Gold Coast Constitution. The Minister of Agriculture in the Gold Coast, the Hon. Mr. A. Casely Hay-

ford, emphasised that this was necessary for political reasons. The present policy is to suspend all cutting out operations in the mass-infested area in the Eastern Province and to establish a line of defence against the mass spread of swollen shoot from this around the western boundary of the mass-infested zone.

It is estimated that disease will kill all the trees in that area in the course of the next seven or eight years. In the north-west of the area, however, which contains some of the best cocoa soils, it is proposed temporarily to postpone treatment and to start rehabilitation as quickly as possible. Elsewhere, where infestation is only sporadic, cutting out will be continued on a voluntary basis, with the assistance of compensation and replanting grants from Government funds. The special department established last year to deal with the mass-infested areas has now been abolished and all operations placed under the agricultural department. It is hoped that in the not too distant future it may be possible, by a combination of controlled cutting out and the use of the new systemic insecticide Hannane, to rid the Gold Coast of the disease.

Mr. Casely Hayford emphasised that only after most careful consideration had the Gold Coast Government decided to abandon compulsory cutting out. To have continued it would have intensified the growing opposition and led to a situation which would have made it impossible to control the disease. It was thus wise to attempt to achieve control with the consent and co-operation of the farmers. They were fully alive to their responsibilities and he was confident that they would solve their problems if they were approached in a spirit of co-operation and good will.

He also emphasised that these new methods involving the use of a highly toxic insecticide would not be applied in practice on a large scale until it had been conclusively demonstrated that they did not affect the wholesome character of the cocoa itself.

The position in Nigeria

The Nigerian position was reviewed in a paper by Mr. R. Johns and Mr. A. V. Gibberd, of the Nigerian Department of Agriculture. Cocoa growing in Nigeria was largely of spontaneous origin and, as in the Gold Coast, it is entirely in the hands of small cultivators. In the early stages it suffered from the lack of technical advice and assistance. Systematic work on the crop cannot be said to have started until 1931, when two scientists were appointed to study the problems of the industry. The work done included selection of improved types and study of cultural conditions.

Swollen shoot disease

The damage caused by swollen shoot in the Gold Coast led to the establishment of the West African Cocoa Research Institute and as a result of this surveys were commenced in 1944 in Nigeria to ascertain whether swollen shoot existed there.

These soon revealed that the disease existed in Oyo and Ondo provinces, but that nowhere had it caused the same widespread destruction as in the Gold Coast. The types of the disease encountered are mostly mild in action and, although they cause serious decline in yields, they take several years to kill the tree.

It was computed that some 245 square miles were either infected or liable to become infected with the disease and that it had become epidemic in a wide area.

To cope with the situation the Nigerian Government established a cocoa division of the Department of Agriculture and initiated a cutting out campaign to deal with the disease. Many difficulties and much opposition were encountered. After four years it was found that cutting out failed to bring the disease under control while work in the Gold Coast showed that where infections exceeded 30% control by cutting out is ineffective.

Consequently in 1950 the policy was adopted of attempting to seal off the highly infected areas by a protective belt to prevent further outward spread. Within this belt survey teams inspect every cocoa farm once every six months and if the disease is discovered all infected trees are destroyed. Simultaneously, survey teams make six-monthly inspections within the perimeter of the mass-infected area to a depth of one mile and any controllable infections are treated in the same way.

Outside the special area parties carry out surveys to locate new outbreaks and to bring them under control. Two outbreaks far removed from the mass-infected area have so far been found and it is claimed that, as no further foci of infection have been discovered, the disease at these points is effectively under control.

It is too early to pronounce upon the success of this policy, but it is politically acceptable and since it was instituted the crop does not appear to have deteriorated.

Other factors in Nigeria

Swollen shoot losses in Nigeria probably rank lower than those from other causes at present. Capsids are probably the most serious pests, while black pod may account for losses up to 30,000 tons of cocoa in bad years. Low productivity is largely attributable to low cultural standards and one of the functions of the Cocoa Division is to bring about changes and improvements in the latter regard. A special rehabilitation section is being built up for this purpose. Apart altogether from disease losses, much of the cocoa in Nigeria is over 20 years old and is progressively deteriorating owing to age. Its replacement and the rejuvenation of the cocoa soils is

Young cacao in Leucaena Glauca shade, Java

an urgent problem. The existing form of cultivation in small, widely scattered blocks is unfavourable to the introduction of improved methods, and the effort is being made to establish easily accessible and larger producing units through the formation of co-operative producers' societies with the aid of funds provided through the Regional Production Development Boards.

French West Africa

The position in French West Africa was reviewed by M. A. Balleyguier, of the Groupement National d'Achat des Cacaos. Cocoa is produced in three territories in French West Africa, *viz.* the Ivory Coast, the French Cameroons and Togo/Gabon; the first is the largest producer. Production is steadily increasing; in 1949-50 it reached 100,000 metric tons, while the present year's estimate is 108,000 metric tons. It has been stimulated by Government subsidies and many young trees are not yet producing. It is estimated that in due course plantations in the Ivory Coast alone should yield 100,000 tons. A recent conference had recommended a five-year plan for extending and improving cocoa production in the Cameroons.

The main trouble is swollen shoot disease, of which at least four forms are known to exist. The worst is the Kongodia form, which resembles the virulent New Juaben strain in the Gold Coast. Over 1,000 hectares are stated to be infected with it in the Ivory Coast. Control measures are being taken and research is being carried out at three research stations which work in close contact with WACRI.

Marketing and distribution problems are important and difficult to solve, the prime need being to assure farmers an adequate and stable return for his produce.

Cultivation in other countries

The threat to cocoa from disease both in West Africa and in the Americas has caused attention to be turned to the possibilities of establishing cocoa growing in other countries. In Malaya and Borneo they were examined some years ago by Professor E. E. Cheesman and developments on some scale have been started; the Malayan developments were described in an article in WORLD CROPS, Vol. III, p. 289. They were reviewed in a paper at the conference by Mr. O. T. Voelcker, Director of Agriculture in Malaya.

Mr. D. H. Urquhart discussed the impressions he gained as a result of a recent tour of Ceylon, Malaya, New Guinea, the Solomon Islands and Java, while Mr. D. H. Henderson, Economic Botanist, New Guinea, discussed the expansion of cocoa growing in New Guinea. Prospects in the

High-yielding cocoa at Lucolela in the Belgian Congo

Belgian Congo were dealt with by Mr. D. Gillett and by M. V. de Bellefroid.

In all these areas there appears to be abundant scope for developments and large areas exist where soil and climatic conditions are favourable for cocoa. In New Guinea and the Solomon Islands the chief difficulty is labour shortage. In New Guinea interesting details were given concerning the successful planting of cocoa between coconuts and much interest is being evoked in a number of countries in the possibility of interplanting it between such crops as coconuts, rubber and oil palms. Mr. Urquhart stressed the need for more soil surveys in order to determine the locations best suited to the crop and referred to the considerable interest in cocoa growing manifested in many countries.

In New Guinea plantations on some scale had been established before the last war, but during the Japanese occupation they were extensively damaged. Throughout the area the need is for suitable planting material, but importations have to be undertaken with care owing to the risk of introducing disease. Propagation methods have to be studied to determine those best suited to particular conditions and scientific services must be available in adequate supply to deal with various problems as they arise. Haphazard developments such as occurred in West Africa must be avoided.

In the Belgian Congo cocoa has already been established in some areas. The chief menace is from capsid bugs. The Belgian authorities claim to have evolved successful methods of dealing with them by the use of insecticides. Mr. Gillett considered that, in the aggregate, there are large areas suitable for cocoa, but they are limited by the restricted occurrence of suitable patches of soil and by the extensive occurrence of swamps and grassland. There are, however, favourable prospects for a big increase in its production as a secondary crop.

Cocoa quality

A good deal of attention is being paid to the improvement of the quality of cocoa and a number of papers were read on research on the fermentation of cocoa both in Trinidad and West Africa. It is currently believed that the quality and flavour of the final product is largely determined by the manner in which the so-called process of fermentation is conducted. This process consists of heaping the beans, surrounded by mucilage as they are extracted from the pods, and leaving them to ferment. This has the effect of converting the sugars and mucilage into alcohols and acids, which makes the beans easy to wash; but it is also considered that it induces changes in the beans themselves and powerfully affects the quality of the product.

In a paper of outstanding excellence Dr. W. G. Forsyth, of the Colonial Microbiological Institute in Trinidad, described work by himself and J. E. Rombouts on the subject. They had examined the changes taking place in the pulp and showed that the initial changes here were mainly due to yeasts, followed by lactic and acetic acid bacteria. This resulted in rapid rise in temperature in the fermenting heap. Concurrently changes take place in the beans themselves, the cotyledons are killed by the rise in temperature and the so-called tannins, which are really a complex mixture of polyphenols, become subjected to enzyme action and changed. These substances were subjected to analysis by the paper chromotographic method. They concluded that changes in the cotyledons take place in the almost complete absence of oxygen and that it was difficult to understand how methods which depend on high aeration of the fermenting heap could possibly be successful.

Messrs. F. W. Cope and K. W. de Witt discussed certain biochemical aspects of fermentation as practised in Trinidad and emphasised the need for greater knowledge of the chemical processes involved; they also discussed the effect of the variety grown on the flavour of chocolate and the

possibility of introducing desirable flavour as the result of plant breeding work.

Dr. J. R. Maclean and Mr. R. Wickens of the West African Cocoa Research Institute, described small-scale laboratory experiments on fermenting cocoa under West African conditions. They concluded that the condition of the pods at the time of fermentation is much more important than the treatments applied during fermentation and drying provided the latter are carried out with reasonable care. Great importance therefore attaches to harvesting pods at the same degree of ripeness. They noted that wide variation in response to treatment had been shown in relation to Upper Amazonian selections recently introduced into West Africa compared with West African Amelonado types. They also, in another paper, summarised their experiences in endeavouring to assess the quality of cocoa by means of a tasting panel and emphasised the difficulty of such assessments owing to variation in individual tastes and taste fatigue on the part of those engaged in making such tests.

A well-shaped cacao tree, Java

Findings of the Conference

In a summing up paper Mr. Paul Cadbury summarised the main points which seemed to emerge from the conference as follows:

(1) This conference records its thanks to the Hon. A. Casely Hayford for the encouraging speech delivered on Wednesday as the Minister responsible for agriculture in the Gold Coast; they welcome his interest and his presence. The members of the conference hope that the personal contacts and co-operation between producers and consumers, scientists and governments in all parts of the world, to which the Minister referred, may continue.

(2) They welcome the evidence from research workers that the work of the last few years in breeding better types of cocoa, and the vegetative propagation of such types, is making good progress. The testing of the different clones for quality and acceptability is a matter of great urgency, as the selection of the best types of plant from this angle is vital to the success of the whole of the experimental work.

(3) The reports on disease control have been, on the whole, encouraging. Political changes in the Gold Coast have altered the angle of approach to the problem of swollen shoot disease. While recognising the very great importance of the new systemic insecticides of which they have heard for the first time, the members of the conference were glad to hear from Mr. Casely Hayford that until it has been proved beyond doubt that these new methods are practicable and will not in any way affect the wholesome nature of the cocoa itself they will not be applied generally.

(4) Positive research into better cultivation and into the theory and practice of fermentation and drying will be of permanent value. The conference is glad to know that in this and other research fields the staffing problem, though still serious, has become less acute during the last 12 months.

(5) First-hand information of suitable areas in the Far East is encouraging from the point of view of new plantings. Cocoa as an additional crop can bring an improved standard to people now living at the subsistence level. In particular, the conference has received reports on Papua and New Guinea and the Solomon Islands, but reports plant no cocoa. The Alliance and other national associations are encouraged to consider what next step can be taken either by individual firms or groups of firms to make a beginning in actual plantings. They hope that the attention of the Colonial Development Corporation, FAO and other appropriate bodies will be drawn to the value of cocoa as a crop in developing backward tropical areas.

(6) Figures have been produced which suggest that, at present prices, supply and demand approximately equate. If confidence is to be given to growers to produce more cocoa more cheaply, manufacturers must demonstrate that, in countries where there is already a substantial use, the market is capable of further expansion and that, in countries where the use is small and chocolate is still an expensive luxury, greatly increased sales are possible. National associations are asked to consider the setting up of a world scheme designed to popularise and expand the use of cocoa products.

Photos: Pp. 419, 422 and 424, Cadbury Bros. Ltd.; p. 423, David Gillett.

Plums and Gages at East Malling Research Station

A Members' Day on plums and gages was held at East Malling Research Station recently. The programme consisted of talks in the plantations on rootstocks and dessert gage varieties by Mr. T. N. Hoblyn and Miss Elizabeth Glenn with trees on view of the combinations described. Special attention was drawn to the heavy cropping of trees on Myrobalan B and the good commercial qualities of Ontario, Oullin's Golden Gage, Cambridge Gage, Jefferson, Bryanston and Late Orange, which all crop fairly heavily and regularly.

Pruning young trees to reduce branch breakage was discussed by Mr. H. W. B. Barlow, who is collaborating with Mr. A. P. Preston. He showed the strong wide-angled crotches that resulted from the application of a growth substance, indole butyric acid, in lanolin to the pruning cuts made in the dormant months.

Mr. J. Crosse outlined the shot hole and canker phases of the Bacterial Canker disease and strongly advocated highworking on resistant stems of Myrobalan B as a preventative measure, at least until a reliable spray programme could be evolved. He had found with cherries that the early leaf-scars in the autumn were easily infected and led to cankers, and was seeking to find if this was true of plums also.

Virus diseases formed Mr. A. F. Posnette's subject. Plums were especially difficult to work with as they showed few symptoms and he had to test suspected plums by grafting on to peach seedlings and mazzards. He showed specimens of plum mosaic and line patterns and described other symptoms. He was finding these diseases very widespread, and although he was not yet able to say how damaging they were, he advised growers not to use rootstocks or scions showing virus symptoms for propagation.

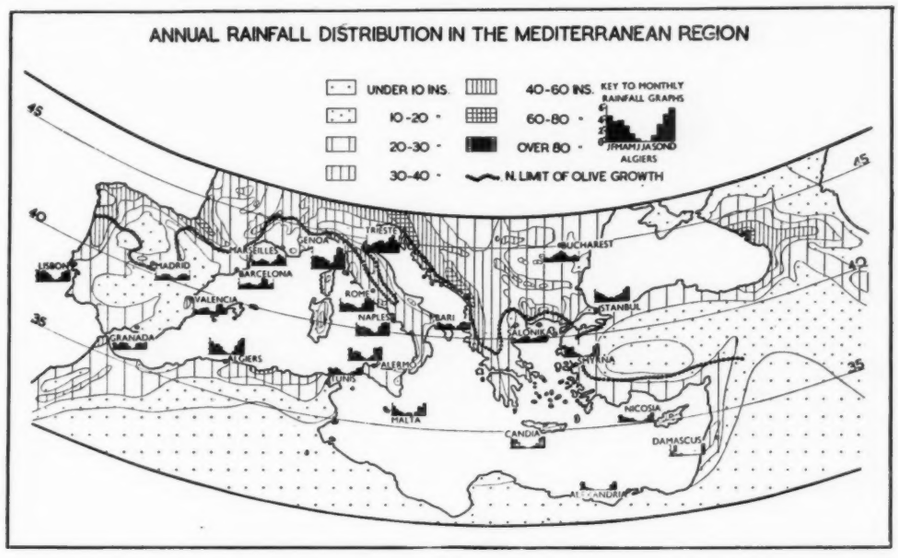
A Mediterranean Survey

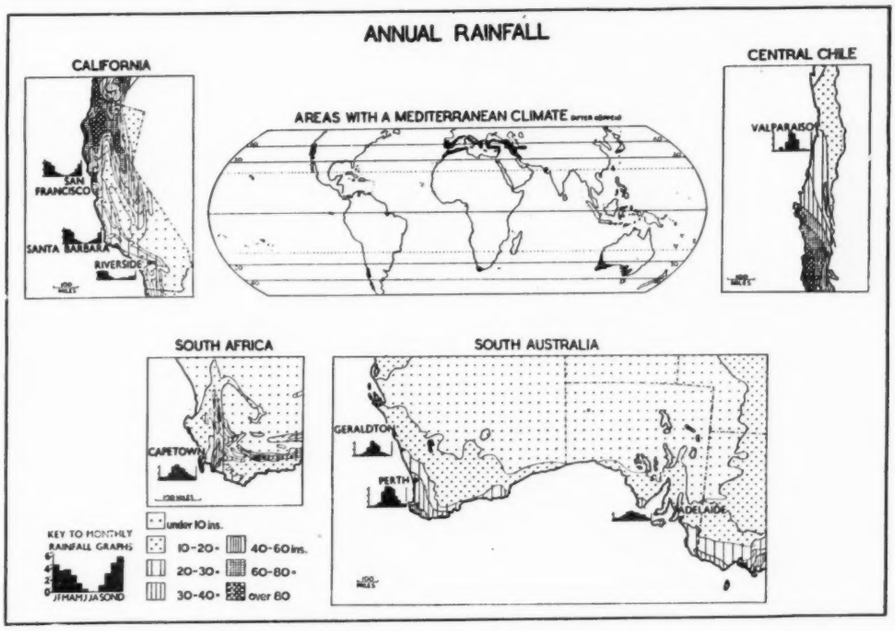
An Example of Fodder Resources Assessment

R. O. WHYTE, Ph.D., B.Sc.

FAO

As a sequel to the article on The Assessment of Fodder Resources which appeared in the October issue of WORLD CROPS, *an account is given below of an actual survey of this type made during the months of March to May 1951 under the auspices of OEEC and FAO in those countries in the Mediterranean area which are members of that organisation, namely, France (South), Greece, Italy, North Africa (French), Portugal and Turkey.*





THE team who carried out the work were: Dr. Olaf S. Aamodt, U.S. Department of Agriculture, Mr. C. M. Donald, Division of Plant Industry, C.S.I.R.O., Australia, Professor Ford S. Prince, University of New Hampshire, U.S.A., Dr. J. W. Rowland, Department of Agriculture, South Africa, Dr. R. O. Whyte, FAO, Rome; and for part of the time Mr. T. E. Williams, Grassland Research Station, Stratford-on-Avon. The whole team surveyed Italy south of Rome, including Sicily, and then divided into two parties (Donald, Prince and Whyte to Turkey and Greece, Aamodt, Rowland and Williams to Tunisia, Algeria, Morocco and Portugal). The south of France was surveyed by Mr. Donald, Dr. Rowland, and Professor Prince.

Objectives

The main objective of the survey was to study the present position of pasture and fodder production in the area, and to make recommendations for its improvement. All field studies were made in co-operation with local technicians familiar with their own country, its soil and climatic conditions. Consultations were held with specialists in all related fields, such as arable crop cultivation, soils and irrigation, animal production, botany and ecology of natural vegetation, forestry and agricultural economics. The team also had access to statistical summaries, statements on production problems, maps, literature and reports relating to the production and utilisation of animal fodder from cultivated crops, pastures or the natural vegetation. They also had to take into account the social and economic problems which existed in the countries surveyed.

This survey is probably unique among fodder surveys in that, although begun on a political basis, it was concerned with one of the most characteristic and well-defined climatic and biological regions of the world, namely, the Mediterranean lands.

Climate in the region

Climate is the outstanding natural feature common to the lands bordering the Mediterranean Sea. At the lower altitudes

in most of the countries visited the climate is one of cool, wet winters and hot dry summers, the so-called ' Mediterranean ' climate which is also found in parts of California, parts of Chile, the south-west of Cape Province in South Africa, and in parts of Western and South Australia. Considerable variations from this basic pattern occur at higher altitudes throughout the area surveyed (where one finds conditions more characteristic of Central and Northern Europe), and in the Anatolian Plateau in Turkey, in the north of Portugal, and along the fringes of the Sahara.

Vegetational characteristics

Apart from the dominant feature of climate, the region is also characterised by natural vegetation able to grow in the winter and to subsist through long periods of summer drought, by an animal husbandry geared to this seasonal production from the vegetation, and by an arable agriculture primarily based on the growth of winter animals.

The limits of the true Mediterranean environment are indicated by the olive tree in its cultivated and wild state, and by the evergreen oaks, predominantly *Quercus coccifera*, in the natural vegetation. This vegetation has been exposed to the destructive influences of man for so long that it is difficult in most countries to be certain of the original climax type. It seems to be generally agreed that Mediterranean macchie occurred along the coastal fringes; typical macchie (maquis) are composed of deep-rooted evergreen, hard-leaved, small trees and shrubs. Away from the coast, and in the lower hills, the macchie formed an understorey in high pine forests. Higher up the mountains and away from sea influences, evergreen oaks, deciduous oaks, chestnut and beech were to be found as dominant species. The vegetation pattern within the true Mediterranean area was probably very intricate and mosaic in character, as affected by slope, aspect, direction of valleys, proximity to the sea, and other factors.

Crop and animal husbandry

Characteristic forms of crop and animal husbandry have developed in this region over the centuries, and have in general been of such an exploitive nature that disastrous denudation of vegetation and soil cover has ensued. In the cultivated land the dominant factors are again the climate, and complex land tenure systems which are an expression of the pressure of population.

The systems of land tenure vary widely, both between different countries, and also within a country. They range from individual ownership or tenancy of large or small properties to individual ownership on a village basis, and to ownership on a tribal basis. The acreage per farm in Italy is either very large (on the estates awaiting subdivision) or very small (the share-cropping or metayage system); in Greece and Turkey the acreage per farm is very small, while in South Portugal many farms are of considerable size. In North Africa we find properties operated on modern lines by French colonists in some areas, and Arab and Berber properties with primitive methods of husbandry in others.

The dominant arable crop over the whole area is wheat, grown in the characteristic wheat/fallow rotation; the villager always likes to feel that he is growing enough wheat at least for the subsistence of his family, and this tends to influence the degree to which he can be persuaded to grow soil-improving and fodder crops on his arable land. Yields of cereals are generally low, and in many parts poor soil structure and serious soil erosion have resulted from mono-cultivation. There has in some regions been good progress towards the first stage in the development of alternate husbandry, the inclusion of annual leguminous forage crops in place of the fallow.

Livestock

The chief characteristic of the livestock industry is the predominance of small animals, sheep and goats, which are generally multi-purpose, producing milk, meat, wool and hair. Dairy cattle are kept in some of the better areas, but these are frequently for meat and work in addition to milk. The general standard of stock is extremely low, and much could be achieved by a better appreciation of the principles of nutrition and by the selection or introduction of improved types.

Most villagers and small farmers throughout the area own some small animals for subsistence milk products (primarily cheese) and meat, and have communal grazing areas to which the stock can be taken. Superimposed upon this village type of animal husbandry are the large flocks kept by the professional shepherds who may or may not be nomadic but who rarely own any land, and thus have little interest in its proper maintenance and use. They obtain most of the summer grazing for their animals at low or no cost on the mountain slopes, in the forests and on the high mountain pastures.

Grazing

There are no pastures sown specifically to provide grazing or conserved hay or silage for stock. After the removal by man with his axe, fire and grazing animals of most of the original climax vegetation, the characteristic grazed ' pasture ' consists principally of shrubs resistant to grazing and/or fire, *Quercus coccifera* in particular, with a patchy and seasonal ground flora composed of species of *Hordeum*, *Bromus*, *Festuca*, *Trifolium*, *Medicago* and *Vicia*. Perennial grasses have survived principally where protected by

A shepherd with his flock beside the River Alphios in southern Greece

shrubs, or in ungrazed forest areas. Outside the true Mediterranean area, *e.g.* at high altitudes throughout the region, in the Anatolian plateau, and in North Africa, different initial climax associations and present-day degraded forms of these are found. The Anatolian plateau was, for example, probably once largely covered by deciduous oak forests, with or without admixture of conifers; now the uncultivated land or pastures are composed principally of perennial grasses and shrubs, in particular *Artemisia herba-alba*, with annual leguminous plants in varying abundance.

Lack of integrated husbandry

The most important undesirable feature of the farming systems of the Mediterranean lands is the almost complete lack of integration of crop and livestock husbandry. This ancient feature arose through

The wild contours of Morocco

the early distinction between the cultivator and the grazier, a distinction which has its origins in the invasions and tribal and racial movements of the past, and which is still expressed in varying degrees of antagonism between the two; arable land is used for growing crops; stock enter arable areas only to clean up residues.

The approach to the problem

This very brief statement indicates the biological, economic and social conditions which the survey party found on visiting and studying the countries in the area. Against this background of general similarities and local differences in conditions and practices they had to formulate their recommendations for the actions needed

Terracing on the steep slopes by the side of Lake Moldeno, Italy

to improve fodder production. They approached this problem in a very broad way, because of the key position of fodder resources and their utilisation in relation to animal nutrition, conservation of vegetation, soil and water, maintenance of soil fertility, and the improvement of the general economic status of agriculture.

The chief emphasis in the recommendations was towards increasing the amount of fodder and grazing to be obtained from the arable land, and reducing the pressure of grazing and browsing on the natural vegetation and uncultivated land generally. This attitude was adopted because it was believed that (a) a considerable quantity of high quality fodder could be produced in properly designed systems of rotation, (b) the cultivation of grasses and particularly legumes would do much to improve soil fertility, and (c) the grazing *in situ* or the return of all animal droppings from the stable to the land would further increase the productivity of the soil and lead to proper integration of crop and livestock husbandry. The reduction of pressure on the natural vegetation would revitalise the dead mountains and make it possible to contemplate conservation of soil, water and vegetation, and balanced land use in those areas.

The trend away from the cereal/fallow system was visualised as occurring in stages, depending upon the present state of practice in a region, and the climatic and other controlling factors. The first step would be from cereal/fallow to cereal/annual legume. There are a number of promising legumes in the Mediterranean countries, some of which are already being grown quite extensively. For example, sulla (*Hedysarum coronarium*), *Vicia faba* and *Trigonella foenumgraecum* are common in Southern Italy and Sicily, while in the Plain of Thessaly and other parts of Greece one finds *Vicia sativa*, *V. ervilia*, *Lathyrus cicera*, *Cicer arietinum*, *Pisum sativum* and *Lens esculentum*.

These legumes (apart from sulla and *Trigonella*) are generally harvested as grain and straw, after reaching maturity. They cannot be regarded as the ideal ultimate objective, but they do represent a considerable advance away from cereal monoculture. The next step should be from wheat every second year as before, to wheat every third year, interpolating one year of grain legume and one of a green fodder crop such as cereal and vetch. The wheat yields would be improved and would approach the total obtained from wheat every second year, while the supply of fodder would be greatly increased. Other alternatives have been suggested for drier areas.

Incorporation of a grazing place

Agronomists in other countries have found that a highly effective means of maintaining and increasing production in cereal areas is by including periods of two years and upwards under sown fertilised pastures grazed by livestock. Through the return of its dung and urine to the soil,

the grazing animal becomes a critical factor in the maintenance and improvement of fertility. It becomes possible to eliminate the annual cultivation of the soil essential in the cereal/annual legume system. It seems highly desirable that the application of this principle to the Mediterranean region should be fully investigated.

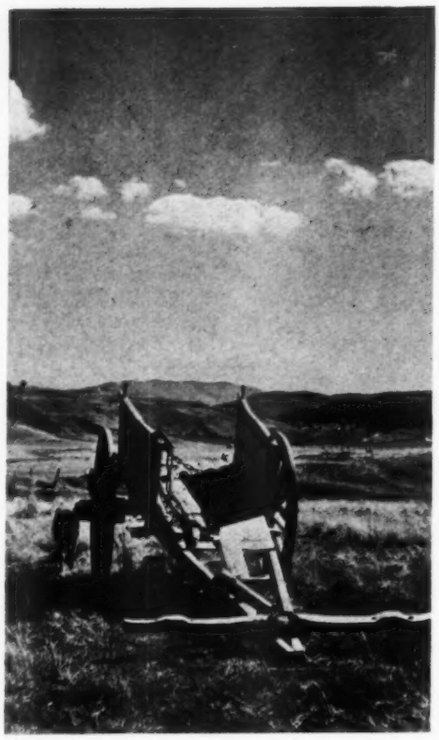
The ease with which it might be possible to achieve a grazing phase in the farming system varies widely in the countries surveyed, according to the land tenure system and the amount of land available. The communal village pastures in Greece could be improved by reseeding, and the volunteer pastures in Southern Portugal could be replaced by a sown pasture properly fertilised and grazed.

Smallholdings

Where properties are small and fragmented, it becomes less realistic to suggest that farmers should attempt to incorporate a grazed pasture in their rotations on arable land. But the problem is not insuperable, and can and is being overcome by the introduction of co-operative land use. Most promising examples of co-operation of this type were seen in Macedonia and other parts of Greece, to some extent in Turkey, and in Morocco. In the Macedonian example, the villagers agreed, at the instigation of officers of ECA Greece, to set aside part of their village pasture for the cultivation of lucerne. Rough but good land adjacent to a village pasture proper was levelled mechanically, and the resulting area of 125 stremata (12.5 hectares) was planted to lucerne in one operation on behalf of 150 villagers co-operating in the scheme. Each villager harvests his own plot separately by scythe. The natural sequel would be for these villagers to rotate lucerne and cash crops on a co-operative basis. When this lucerne field at Stavros is ploughed in four or five years' time, the villagers might well agree to set aside a piece of their jointly-held arable land for a new co-operative lucerne stand, and to grow their cereal crops on the land at present carrying lucerne.

Pasture species

It is believed that a range of pasture species is available to meet the needs of much of the Mediterranean area. With short seasons and low rainfall, pastures of regenerating annuals such as *Lolium rigidum*, *Bromus mollis*, *Medicago tribuloides* and early varieties of *Trifolium subterraneum* or other *Trifolium* species give good green feed followed by satisfactory summer dry feed *in situ* for grazing small stock. Where the season is longer and



Typical scenery on the uplands of Calabria, Italy

there is a better distributed rainfall of 400-450 mm., it should be possible to use perennial grasses. *Phalaris tuberosa* is almost certainly the most promising for regions of 450-900 mm. rainfall. Other perennial grasses deserving a trial are *Ehrharta calycina*, *Oryzopsis miliacea* and the Mediterranean types of *Dactylis glomerata*. The annual species of *Medicago* and *Trifolium* or lucerne can be used successfully in mixtures with these grasses.

In view of the low state of soil fertility throughout the cultivated land of the Mediterranean, and the marked response which is obtained to applications of phosphate, great stress was laid by the survey team on the need to ensure that such pastures receive adequate dressings of fertilisers. It is quite unlikely that pastures of the species mentioned will succeed if sown without fertilisers.

The mountain region

The Mediterranean countries are very mountainous, and there is frequently a clear-cut demarcation between the mountains on the one hand, and the valleys and plains on the other. This is perhaps most marked in Southern Italy and Greece. In Greece 80% of the land surface is mountain, and 40% of the agricultural population lives there.

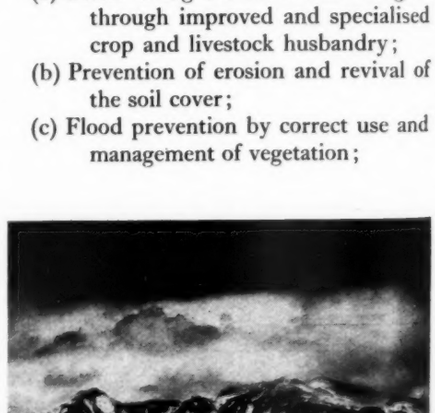
The mountains were once fully protected by a climax forest cover. Now about 30% of the hill and mountain land has been ruined for reclamation and further productive use, another 30% is being misused and is deteriorating at present, while the remainder is in a state of only reasonable equilibrium.

Before reclamation work can be undertaken (a mammoth task about which it is difficult not to be pessimistic), and appropriate recommendations made regarding the correct use and management of mountain land, control of grazing, and other actions, it appears to be essential to work out standards of land classification applicable to the Mediterranean environment, on the basis of data concerning slope, plant cover, soil and degree of erosion.

The development of land-use methods and agricultural and grazing systems for the mountain areas suffers considerably because these areas are the responsibility of more than one authority. There is a need to regard the mountains as an entity in themselves, and to allocate their management and improvement to one overall authority. This may be a special division of mountain resources, or a special co-ordinating committee, or a high-ranking officer with the proper broad outlook on the mountain problem.

The OEEC Mission stated the following to be the long term objectives of such an authority:—

(a) Better living for mountain villagers through improved and specialised crop and livestock husbandry;
(b) Prevention of erosion and revival of the soil cover;
(c) Flood prevention by correct use and management of vegetation;



Morocco. The Atlas Mountains in the background

The survey team (*left to right*) : **Dr. J. W. Rowland, Mr. C. M. Donald, Dr. O. S. Aamodt, Prof. F. S. Prince and Dr. R. O. Whyte**

(d) Provision of sources of perennial water from springs and rivers;

(e) Revival of production from forests; and

(f) Increase in supplies of small wood for domestic fuel.

It is not suggested that the proposed mountain authority should at once take over all land which might be classified as mountain, but that this should be done progressively, profiting from experience and when facilities become available, one critical mountain catchment area after another being taken over.

Forest improvement

It is frequently argued that it is too much to expect that all the surplus population of these Mediterranean countries should find employment in agriculture, and that secondary and other industries should be developed in the towns and cities. The Mission felt that an alternative outlet could well be provided by conservation work and by forest management and utilisation in the mountain areas. This would not entail movement of population from the villages, and would provide the remaining agricultural population in the mountains with a market for their produce, and an incentive to adopt better methods. A scheme of exactly this type is in progress, if only temporarily, on ECA funds, in the heavily eroded mountainous areas between Serres in Macedonia and the Bulgarian frontier. Although a forest climax region, Mediterranean countries such as Greece have to import much of their timber from Sweden.

The Mission fully realised that there are very large numbers of sheep and goats in the mountains, and that many people depend upon them for their livelihood and subsistence. They have therefore made recommendations for the short-term improvement of the fodder and grazing resources in these regions, in the hope that finance and direction may be found for the long-term measures at the same time.

Conclusion

It is one thing to write a report analysing a problem and making a number of well-considered recommendations, but quite another to carry it out. In an attempt to ensure that this survey would lead to some constructive work, the Mission recommended that a Mediterranean Grassland Committee be formed, with the primary objective ' to establish a continuing contact between the technicians of the various countries through joint planning and co-operation in regional projects, field examination of problems and demonstrations within each country, discussion of mutual interests and techniques, and the exchange of materials, reports and publication.' It was thought that such an organisation would require a central co-ordinating officer, whose duty it might be, among other things, to produce a journal devoted to Mediterranean agriculture.

Photos : Pp. 427 (top) and 428 (top), E.N.I.T. ; pp. 426, 427 (lower) and 428 (lower), Thos. Cook & Son Ltd.

Zanzibar Investigates Jute Substitutes

During 1949 the attention of the Department of Agriculture was drawn to the serious world shortage of jute and the need for substitutes for this material.

Four jute substitutes are being grown experimentally at the Kizimbani Experimental Station, reports the Director of Agriculture for Zanzibar. These are *Urena lobata*, which originated from the Belgian Congo, Ramie (*Boehmeria nivea*) from Amani, Rozelle (*Hibiscus sabadriffa* var. *altissima*) and Mauritus hemp (*Furcraea. gigantea*) of local origin.

So far, the Ramie has grown rather poorly although this may be due to the site chosen for the plot. Last *masika* it was replanted in what is hoped is a more favourable site.

The Mauritius hemp has made slow growth and is not yet ready for harvest.

After initial difficulties in growing Rozelle hemp, a sample of this crop was harvested in March 1950, and retted locally in the Mwera River at Kinuni Moshi. A fairly attractive sample of fibre was produced and this was sent to the Colonial Products Advisory Bureau for expert examination and appraisement. A very detailed examination was made of the sample and an assessment of its commercial possibilities was made by the British Jute Trade Research Association. The conclusion reached was that in view of the short length and unsatisfactory quality of the fibre, commercial production would not be worth while, at any rate for export purposes. Trials with Rozelle have therefore now been discontinued.

In October a sample of *Urena* fibre was produced at Kizimbani and submitted to the same authorities. A report has recently been received which is much more sanguine than that received upon the Rozelle. This report contains the following remarks:—

' The coarseness of the fibre near the root and its harsh feel suggests that the plants may have been over-matured when they were harvested. In view of the fact that *Urena lobata* is more similar to jute in its characteristics than most of the stem fibres examined at the Bureau, it would seem worth while carrying out further growing trials provided the preparation of the fibre can be improved and provided there are reasonable chances that the cultivation of *Urena* in Zanzibar would be a commercial possibility.'

Urena cultivation has been continued at Kizimbani and a larger area is now being harvested and the fibre retted. There is little doubt that the quality of the fibre can be greatly improved.

Biological Control of Insect Pests on Crops

R. J. A. W. LEVER

It is generally accepted that insects take a yearly toll of ten per cent. of the crops, trees, timber, stored products and clothing of man. With the steady rise in the world's population, this loss of potential food is of increasing importance and has to be countered more thoroughly than in the past. This is especially so in view of increased chances of pests being spread by aircraft which now reach in a matter of hours places previously days or even weeks apart. Recently many new and potent insecticides have been devised by chemists, but besides chemical control by means of sprays, dusts and fumigants, and various cultural and mechanical methods that can be practised by cultivators, biological methods can also play a very important part.

BIOLOGICAL control aims at utilising the natural enemies of insect pests and noxious weeds and the bulk of these happen to be themselves insects. Every gardener will have observed with delight the brightly coloured, spiny grubs of ladybird beetles devouring the harmful green fly or aphid feeding on his roses or other plants. This is an everyday example of biological control of a pest by another insect which is beneficial to man.

Without going into the history of the development of biological control there can be little doubt that the originator of the idea in Western Europe was Erasmus Darwin, Charles Darwin's father, who suggested the method as long ago as 1800. It is sometimes forgotten, however, that the Chinese had for centuries encouraged certain large tree ants to nest in their citrus trees in south China so as to kill off caterpillars and other insect pests. Similarly the Arabs in the Yemen did the same with a predaceous mountain ant which they introduced to attack a harmful species of ant in their date palms. Both these cases involved the use of predaceous insects, not true parasites—a difference to be explained later.

Early examples

The first instance of the large-scale utilisation of this method was in 1873, when a predaceous mite (actually not an insect as it is eight- and not six-legged) was dispatched from the United States to France for the control of an aphid doing great damage in the vineyards. Other long-range introductions soon followed, but it was the spectacular success of a scarlet ladybird which in 1889 was sent from Australia to California to prey on the cottony cushion scale in the citrus orchards which gripped popular imagination. Unfortunately over-optimistic hopes were founded that here was a cheap, easy and infallible method of controlling insect pests without the farmer being called upon for any effort or expenditure. The passage of time, however, soon showed that this ideal was not by any means always realised.

Parasites and predators

In considering insects which prey on others it is necessary to distinguish between parasites and predators. In the case of a parasite (normally some kind of wasp or fly) the female lays her eggs in or on the body of the prey or 'host' or within its eggs. Here the young parasites gradually develop at the expense of the host which is thereby killed. Only one such host, often a caterpillar or grub, is required for the nourishment of the parasites, usually internal feeders, which may number one or many.

A predator, on the other hand, requires for its development several individuals of its host which are seized and eaten outright. Examples are the larvae of tiger beetles or ladybirds which feed directly on a number of caterpillars and green flies. However, to the host or prey the result is similar whether it is attacked by a parasite or predator, *viz.*, its death.

Some examples in tropical islands

Three instances of the successful control of pests by means of introduced parasites and predators took place in the Colony of Fiji in the Western Pacific Ocean. All occurred within 12 years and all were cases of foreign insects deliberately brought in after careful scrutiny against pests of the coconut palm.

The earliest, in 1925, was the introduction of a species of fly from Malaya (where it parasitises a related insect) against a very serious caterpillar pest on the leaves of the Fijian palms. Within 12 months of the liberation of these small, grey flies it was difficult to find specimens of the noxious caterpillars in the crowns of palms throughout most of Fiji. It so happens that the writer, having served both in Fiji and in Malaya, has seen the parasite at work in the two countries—4,000 miles apart—and can appreciate the difference that the parasite fly has accomplished as shown by the state of the palm fronds.

Three years later another introduction was made, this time from Trinidad in the British West Indies, whence a small, variegated ladybird was brought in order to control a scale insect. These pests had caused a yellowing of the normal dark green colour of the coconut leaves resulting in poor yields of copra, but within the year (1929) following the release of these beetles, the scales had been so effectively tackled by the white, tufted larvae of the ladybird that the palms had recovered their usual colour and the pest was soon exceedingly scarce in all the islands, not only on coconuts but also on bananas, another food plant.

There was yet another coconut pest to be dealt with in the shape of a blue-and-orange leaf-beetle whose grubs mined within the fronds of the palms. Search in Java revealed a minute wasp-like parasite which laid its eggs within the larvae and pupae of a beetle related to the Fijian one. On release of these small insects in Fiji in 1937 the damage to the palms was

checked owing to the reduction, and in certain islands the literal extermination, of the pest.

Biological control

It will be seen that there is something common to all the above examples, *viz.*, the introduction into tropical islands, having an equable climate and a restricted insect fauna, of a foreign parasite or predator of a pest, whose natural enemies were previously absent or ineffective. Other successful examples of spectacular success have occurred in Hawaii, the West Indies, Mauritius, and the Seychelles—all tropical islands exhibiting the conditions mentioned above, including relatively few main crops grown to a high standard of agriculture. This is particularly the case in Hawaii with its well-organised sugar industry.

True islands and ecological islands

Even such an obviously non-tropical island as New Zealand has had several beetles and plant bugs controlled by introduced insects, but here geographical isolation and a rather scanty fauna have compensated for its cold climate. The explanation for the success of biological control in California is similarly due to the fact that the areas where citrus groves occur can be regarded as isolated to the north, east and south by high mountains and deserts as effectively as they are by the ocean to the west. Consequently, this area is an ecological island and this holds good also for Western Australia, Southern Queensland, Egypt, Iraq and in Kenya where lofty mountains and huge lakes are effective barriers. Climate and topography therefore determine areas where biological control may succeed irrespective of the absence of surrounding sea.

What is required of a parasite . . .

The ideal requirements for a parasite are, of course, never found in any one insect, but the following characters determine its suitability for introduction: adaptability to its new environment ; small range of hosts which it attacks; synchronisation in development with its host; efficiency in finding the host (especially in the earlier stages when less damage will have been done); rapid dispersion or spread; being more prolific (either by laying more eggs or having more generations) than its host and, lastly, a relative freedom from parasites of its own which would naturally limit its multiplication.

. . . and of the entomologist

The person responsible for the introduction of a parasite must have full information on the correct identity of the pest and on arrival in the chosen country, must find out all about the life-history of the nearest related pest and of its parasites and predators in order to choose the most suitable insect for the purpose which must be dispatched free from its own parasites.

Ladybird eating aphides

Practical matters such as the best methods of feeding and breeding the insects, the possible use of cold storage for slowing down the development of the parasites, the best stage and time for shipment (normally done nowadays by plane), must all be seen to. Details of how they are to be handled during the journey, if unaccompanied, the method of rapid treatment on arrival and subsequent liberation are also very important. The writer has had the unenviable experience of taking over parasites which had been held so long in a refrigerator that few were able to develop, of receiving parasitised bugs which on arrival after a long voyage were moribund, and of having a carefully prepared cage placed on transhipment so near the boiler-room that the plants were all but dead at the end of the unaccompanied voyage! This kind of incident is less frequent nowadays with regular air services, but when it does occur little can be done though months of work can thus be reduced to nothing through unanticipated events occurring after dispatch of the consignment.

Practical difficulties

Mention was made previously of the need for adequate accuracy in the identification of the pest to be tackled; in the middle 'thirties a case of mistaken identity in an African mealy bug caused a great deal of unnecessary work before it was realised that the insect was new to science and so had not yet been described. When this was appreciated a search was made for a parasite in an adjoining territory and gave successful results. This brings home the necessity for what might be called academic research work, which is often in fact of the utmost practical value for the field entomologist.

He, too, has his problems not directly related to the insects themselves such as payment to labourers for collecting large numbers of insects in the field, especially if these are unpleasant to handle, *e.g.* are covered with irritant hairs or spines, or live in such unattractive substance as offal, dung or semi-putrid plant material, or in ant-infested trees. Then the question may have to be decided if payment is better made by the hour or by task work, *i.e.* so much for so many insects collected, with a higher rate for uncongenial work such as night collection of nocturnal insects.

In the case of the introduction into Fiji of some of the parasites of the mealy bug previously referred to, an outbreak of smallpox led to the ship being quarantined on arrival for no less than five weeks before the passengers and the parasites could be landed. This unanticipated delay naturally led to great difficulty in keeping the insects going under very unfavourable circumstances after a long voyage on shipboard. Curiously enough, a similar type of delay occurred three years later when another lot of coconut parasites from Java were held up through an outbreak of cholera on board and an alternative host had to be used for breeding the parasite during the quarantine period which fortunately occurred on an island with healthy coconut palms.

Certain parasitic flies are very particular about the amount of sunshine, shade, temperature and humidity so that attempts are usually made to simulate these conditions in their breeding cages. In one such case the bulk of a stock of very valuable flies were found, for no obvious reason, one morning lying dead in their cages. It was eventually decided that failure to boil one of the feeding cloths had probably resulted in alcoholic fermentation of the honey and sugar used, thereby causing the death by alcoholic poisoning of some

300 flies at a very critical time in the breeding programme.

Such are some of the problems which may crop up in this work.

A recent successful introduction

Although many of the most quoted examples of biological control were made several years ago, it is interesting to give two very recent cases. This particular work was done early in 1948 and involved the two islands of Saipan and Rota north of Guam in the Marianas, lying east of the Philippines. Despite a beetle having been known to the Japanese for several years as a severe coconut pest, nothing had been done to check it. When these islands came under American control, however, it was decided to control the leaf-beetle which was doing very extensive damage to the coconut industry. An entomologist succeeded in introducing from Malaya a parasite of the larvae and pupae which was later successfully recovered in the field, *i.e.* bred from young stages of the beetle collected from palms after the liberation of the parasite.

A much smaller Malayan egg parasite, measuring only about one-thirtieth of an inch, was also released early in 1948, but is assumed not to have become established on Saipan and Rota; however, as the beetle has been checked by the larger parasite this is of little importance.

Two species of larger Braconid wasps were sent from Malaya during 1948 and 1949 to control an Asiatic fruit fly which became established in the Hawaiian Islands as a result of increased war-time traffic. Recovery of these two insects has recently been reported so that the chances of the control of this alien fruit fly are very encouraging.

Non-insectan biological control

So far all the examples of control mentioned, with the exception of a passing reference to a mite, have been of insects but other organisms also exert control on harmful insects. One of the best known of these is the giant toad from Central and South America, which on account of its efficiency has been introduced into the West Indies, Philippines, Queensland, New Guinea, Fiji, and very recently into Mauritius for the control of white grubs of sugar cane and other pests.

For many years attempts to control insect outbreaks by using bacteria, fungi, and viruses have been attempted, but with little success as the problems of creating an epidemic among the pests when it would not normally occur have been unsurmountable. If atmospheric conditions are ideal for these lower organisms then there is no need for laboratory culturing to accelerate heir spread. However, there is a hope that certain of the *Aspergillus* fungi may be of use against certain mealy bugs.

Biological control of noxious weeds

This article deals with the control of insects by other insects, but it is necessary to make a brief reference to the fact that noxious weeds have in several cases been checked by certain insects which are regarded as being beneficial to man since they attack economically undesirable plants. The best known case is that of the control of the ' prickly pear ' in Australia from 1925 onwards by the introduction of a South American moth whose caterpillars tunnelled into the soft pads of this cactus and soon checked its spread over thousands of square miles of valuable land.

Another instance on a much smaller scale, but of equal importance to the pastoralists concerned, was the checking in Fiji of a waist-high weed (*Clidemia*) popularly called the sun plant which is supposed to have arrived accidentally prior to 1890 from South America and rapidly spread throughout the best dairy land in Fiji. Following the introduction of a small thrip from Trinidad, B.W.I., the plant was soon checked through the terminal shoots dying back from the insects' attacks. Cattle were free to graze in previously overgrown areas, and the harvesting of coconuts was also possible in hitherto densely covered plantations.

Permanence of biological control

Although the enormous post-war range of new insecticides (particularly systemic compounds absorbed by the plant) holds out hopes of controlling many insects, it is still necessary to apply these regularly. With biological control, however, it is unnecessary to incur this periodical expense as, once the agents are successfully established, the pest is permanently repressed and outbreaks are dealt with by its parasites which breed upon it and check its further spread. It must be said, however, that both with locusts and tse-tse flies control by parasites is impossible.

This means in effect that biological control entails an initial heavy expenditure —one or more entomologists working abroad for perhaps a fairly long time— instead of a constant annual, or sometimes monthly, recurrent expenditure on spraying and dusting equipment and personnel to carry it out.

Photo : Shell Chemicals Ltd.

CORRESPONDENCE

Insecticidal Control of Coconut Pests

TO THE EDITOR,

Sir,

Dr. Child, in his most valued article ' Research on the Coconut Palm,' published in WORLD CROPS, Vol. 3, No. 6, of June 1951, has mentioned under Pests and Diseases that it was normally neither practicable nor economic to control coconut pests by the use of insecticides. I wish to add that work carried out here in India and Indonesia on insecticidal control of these pests has given encouraging results.

In India, the rhinoceros beetle, *Oryctes rhinoceros* L., has been found to be successfully controlled by spraying BHC (gamma isomer) in its breeding places. A very low concentration of 0.01% BHC in any type of breeding material is sufficient to kill all the grubs of the beetle. Recently our work on the control of the coconut caterpillar, *Nephantis serinopa* Meyr., with 0.2% DDT spray has also given satisfactory results. Tall coconut palms were sprayed with ordinary Hyject sprayers, having 80 ft. long hose at a nominal cost of less than 2 annas per tree.

In Indonesia, Leefmans and Awibowo (1935/36) found an effective method for control of *Artona catoxantha* M., a well-known and serious pest of coconut palms in Java, by dusting with a mixture of dusturan and talcum powder. According to them, the cost of treating a centre of 2,000 trees will be about 1,078 guilders, while had they been left untreated the loss would have been about 52,000 guilders. In later years Van der Vecht (1939) found spraying with a suspension of derris powder and talc in water to be cheaper and having persistent after-effect.

Yours faithfully,

K. K. NIRULA.

Central Coconut Research Station, Kayangulam, S. India.

August 30, 1951.

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The columns of WORLD CROPS are open to correspondence and the Editor welcomes letters from readers supplementing and commenting on articles or on other matters within our sphere. Limitations of space may necessitate the abridgement of letters.

Improvements in DDT Spraying

G. A. EMERY, M.A.

The Murphy Chemical Co. Ltd.

The advent of DDT marked a turning point in the history of insecticides. Up to that time insecticides, as distinct from ovicides and fungicides, had either to hit the insects or be consumed by them. Unlike these, DDT and related compounds are absorbed through the feet of insects and their compounding and application call for special methods.

WHEN DDT first became available it was formulated in the forms customarily used for insecticides at that time, namely as dusts, low concentration wettable powders, emulsions and solutions. Little was known about the relative merits of the different types of formulation and choice was frequently a matter of personal preference.

Since then a great deal of work has been done on the mode of action of DDT and related insecticides and the comparative efficiency of different types of formulation for different purposes. There has been little fundamental change in the concentration or composition of dusts or emulsions, the greatest advances having taken place in the production of suspension sprays. Some of the earliest wettable powders contained only 5% to 10% DDT, although the content was soon raised to 20% on the grounds of convenience and to save packing space. Considerable technical advances in the preparation of wettable powders of higher concentrations have been made and nowadays a general standard material is 50% DDT; some specialised products contain 75%. The object of increasing the DDT content of wettable powders is to reduce the bulk of material for transport, particularly overseas, and thus to reduce the cost of the material to the farmer.

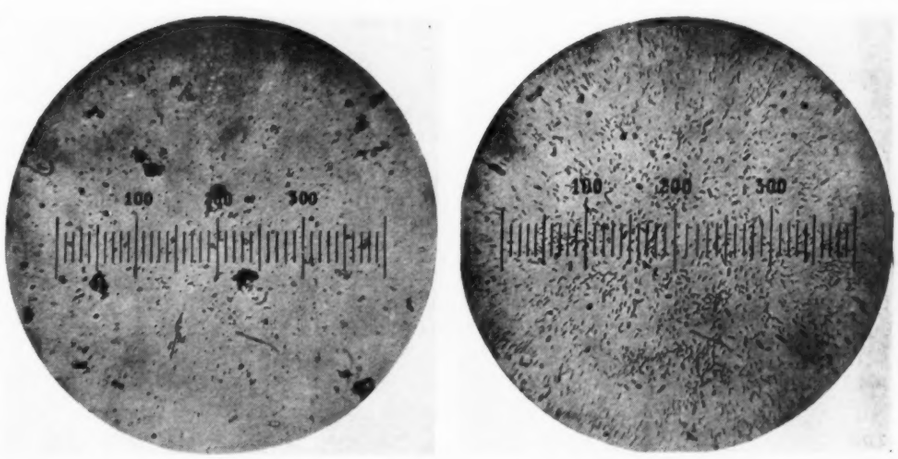
Mode of action of DDT

The mode of action of DDT and related insecticides demanded a new approach to the question of formulation. These insecticides act by being picked up on the feet of insects, rather than by absorption through the general body surfaces or through ingestion. It is therefore essential that an even film of readily available ' detachable ' particles should be present in order that these can be readily picked up by the insects moving over the sprayed surface. There are, of course, exceptions to this rule, notably in the case of plant-sucking insects such as aphids, which do not move about freely. Here DDT appears to be more effective when applied in the form of an emulsion which thoroughly wets the general body surface, although it has been shown in many cases that most of the insecticidal action probably results from the oil or solvent rather than the DDT.

Many workers have investigated the ability of insects to pick up DDT from different formulations applied to a variety of surfaces, and have compared the mortality rates with the amount of DDT picked up. The results show a direct relationship between the mortality and the weight of DDT picked up and retained on the feet of the insect, but indicate that the nature of the surface has a considerable influence on the ease with which an insect can ' detach ' the DDT.[1] A further fact which has emerged is that in many instances the DDT may be absorbed into the surface and thus rendered completely unavailable insecticidally.

The use of emulsions rather than wettable powders, or the incorporation of oil in formulations has sometimes been advocated to increase the efficiency of the DDT. If one tests formulations on a glass plate, this contention is borne out, provided the insects are exposed to the plate while the oil film is still wet. In such circumstances it will be found that a kerosene solution or an oil-containing material is superior to a wettable powder or dust, but once the solvent has dried off and the DDT starts to crystallise, there is a very rapid drop in insecticidal effect. This apparent advantage of a kerosene solution or an oil-containing spray is only observed on non-porous surfaces such as glass. If the insecticide is tested on a porous surface, such as plaster or a leaf, it is seen that the most effective preparations are wettable powders, followed by emulsions with kerosene solutions as the least effective. This order of efficiency is linked with the rate of absorption of the solution into the sprayed surface.

The loss of efficiency of a kerosene solution sprayed on glass when crystallisation commences, might at first appear anomalous, but is presumably due to the fact that the crystals are needle-shaped and tightly adherent to the surface. If, instead of a kerosene solution, a solution in urea resin is employed, crystallisation increases insecticidal efficiency. In this case it will be observed that the crystals stand upright as a pile and are therefore easily detached.[2] The same explanation would account for the drop in efficiency of an emulsion on drying. For most practical purposes the most efficient form in which DDT can be employed is thus as a water dispersion of



Micro-photographs comparing crystalline paste material (*left*) **with good quality dispersible powder** (*right*)

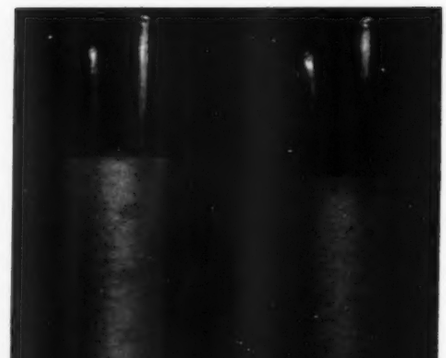
solid particles, as the loss by absorption into porous surfaces is reduced to a minimum and the particles are readily detached from almost any surface.

Dusts

DDT in the form of a dust is easily picked up by an insect and, of course, is not absorbed into porous surfaces. On the other hand it is extremely difficult to control a dust and only a small proportion will adhere to foliage. The deposit is rapidly lost as a result of the action of wind or rain. Furthermore, the presence of a large amount of inert base has a definite masking effect on the DDT, thereby reducing its efficiency. Nevertheless dusts will continue to be used in many cases, because of non-availability of water for spraying or because of the physical difficulty of bringing spraying equipment on to the land. In addition dusting equipment is much lighter and the application of a dust is quicker. The masking effect of an inert base can be seen even in the case of wettable powders. Given equal particle size it is found that a 50% powder has a significantly higher efficiency than an equivalent quantity of DDT contained in a 20% powder; the difference becomes very marked when a 10% or 5% preparation is examined. Thus the increase in strength which has taken place in wettable powders from the desire to save freight has also resulted in an increase in insecticidal efficiency.

Optimum particle size

Other factors, however, also affect efficiency, and a good 20% wettable powder may in practice prove more effective than a bad 50% product. The reason is that there is a certain optimum size for DDT particles for efficient insecticidal action. If too large, they will not be picked up by the feet of the insects walking on the surface or they will be shaken off before the DDT can take effect; if too small, they can be absorbed into porous surfaces. In practice this means that the finer the DDT particles the better, as no grinding will reduce them below the optimum size. Workers at the Colonial Insecticide Research Unit[3] have investigated the effect of varying particle size, in this instance chiefly on mosquitoes, and have shown that on absorbent surfaces, such as dried mud, the optimum size lies between 10 and 20 microns, although on non-absorbent surfaces particles below 10μ are even better than those between 10 and 20 microns. It is difficult to measure such small particles as the finest sieves have an aperture of some 40 microns, but it will be seen that a good criterion for a wettable



These cylinders contain suspensions, each of 5% concentration, of (*left*) DDT paste and (*right*) DDT wettable powder. After thorough mixing, the cylinders were allowed to stand for 30 minutes before the photograph was taken

powder is that a very high proportion should pass through the finest sieve, such as a British 300 mesh sieve or American 325 mesh. Particles failing to pass a 300 mesh sieve can be regarded as wasted, while a proportion of those passing through will obviously be above optimum size. Fineness of particle size is important from other aspects as well. The finer the particles the more complete and uniform will be the covering of the sprayed surface and therefore the greater the likelihood of an insect coming in contact with DDT particles.

More important is the effect on the suspension qualities of the powder. The problem of suspension is of vital importance to users of knapsack sprayers or other apparatus which has no agitator. If the particle size is large the suspension qualities will be poor. With many wettable powders it will be found that after as short an interval as three minutes practically the whole of the DDT has settled on the bottom of the vessel. In some cases it may drop below the level of the outlet and remain in the tank; in others it will be forced out with the first fraction of the spray. The result is the same—a large part of the spraying will be carried out with almost pure water. Many cases of failure of DDT to control insects are undoubtedly due to the use of such materials. Even with the best of wettable powders, if the spray tank is not emptied quickly or agitation employed, the rate of sedimentation may be such that it is difficult or impossible to obtain a diluted spray of uniform character. That more cases of poor control have not been noticed can probably be attributed to the fact that in many instances DDT is applied at rates far in excess of those required. In addition the particles which remain in suspension longest are the fine particles having maximum insecticidal efficiency.

If the particle size is too coarse, blockage of nozzles may obviously result, but this can be readily guarded against by straining the insecticide as it is poured into the sprayer.

Importance of suspension

Owners of power spraying equipment sometimes disregard the importance of suspension as their machines have powerful agitators that will keep the spray uniformly mixed. But the fact that a wettable powder has poor qualities of suspension means in most cases that it will also consist of large particles, and however well the spray is agitated, the resultant film will have a relatively low insecticidal efficiency. The variability of results with wettable powders, rapid settling out and frequent blockage of nozzles, have led to the continued use of emulsions, despite the fact that such preparations are generally less effective. They have, however, the advantage that the DDT stays in suspension very much longer and that there is no blockage of nozzles. Furthermore, they are very simple to use. It is easier for a labourer to measure out a container of liquid than an accurate quantity of powder; also emulsion concentrates have merely to be poured into water for an effective dispersion to result, whereas wettable powders require some care in mixing. A preparation possessing nearly the suspension qualities of emulsions and the insecticidal efficiency of the best wettable powders consists of an aqueous micro-crystalline paste. The preparation and properties of such a material containing approximately 50% DDT were described by the author in a paper read at the Second International Congress of Crop Protection held in London in 1949. The principle of such a material was conceived in 1943[4]

and the technique of manufacture perfected over a number of years. The object was to obtain a solid suspension in water without the use of oil or solvent. Apart from the fact that such liquids increase absorption into surfaces and render the DDT film difficult for the insects to remove after the liquid film has aged, there is definite risk of causing damage to plants or animals through this increased absorption.

Micro-crystalline pastes

The principle underlying the preparation of this micro-crystalline paste is the emulsification of molten DDT with a hot, aqueous solution of emulsifier, followed by heat treatment to induce crystallisation of the metastable globules of DDT. The result is a thick paste of uniform, rod-shaped crystals, measuring some 7 microns × 1 micron, with a smaller quantity below 7 microns and up to 12 microns in length. Many difficulties have had to be overcome, such as the interlocking of needle-like crystals to form a solid mass and the loss of suspension qualities under tropical conditions, but after these have been surmounted, a product of remarkable qualities has been achieved. The particle size lies within the optimum range for efficient pick-up by insects, and no oil or solvent is present to increase the absorption of DDT into sprayed surfaces. The particle size is sufficiently large to avoid undue absorption into porous surfaces and, perhaps most important of all, the power of suspension is much superior to that of any wettable powder, although slightly inferior to that of an emulsion where suspension is assisted by the fact that the specific gravity of the solvent is less than that of water. The accompanying figure gives a comparison between the rates of sedimentation of such a paste suspension over a period of ten minutes, and of three representative wettable powders. After four minutes, during which the very small number of larger crystals is deposited, the rate of sedimentation is extremely slow. The method of obtaining these curves was to make a suspension of the material, containing 2.5 grammes of DDT per litre, mix adequately, allow to stand for the required interval of time, and syphon off the top 900 ml. of liquid. The quantity of DDT remaining in the bottom 100 ml. of the suspension was then determined.

It will be seen that the differences between samples of commercial wettable powder may be very great. To employ a material such as the one represented by curve D on the diagram, in knapsack sprayers, is bound to lead to disappointing results.

A more stringent test of suspension is a

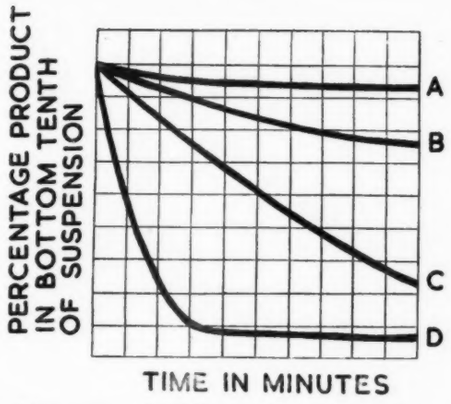


Diagram showing the comparison between rates of sedimentation of three wettable powders (*A, B and C*) and a paste suspension (*D*) (*see text*)

modification of one suggested for DDT materials for malaria control. This involves preparing a suspension containing 2.5% DDT and, after shaking vigorously in a bottle, allowing it to stand for 30 minutes, after which a sample of 25 ml. is withdrawn from the centre at a depth of 9 cm. While a DDT wettable powder normally regarded as of first grade may show a DDT content at that point in the suspension of about .5% or 1.0%, the micro-crystalline paste showed 2.25% under similar conditions.

Additional advantages of pastes

A further advantage of the paste formulation is the absence of inert base. This has two major effects. Firstly, it reduced the visibility of the deposit.[2] Secondly, it renders the preparation of very high concentrations possible. For example, it is perfectly practicable to spray with a suspension containing 10% actual DDT; walls can be sprayed with an atomiser, such as a paint spray-gun, with very little water, so that there is minimum wetting of the surface. While the normal rate of dilution of the paste for horticultural spraying is 1 lb. per 100 gal. of water, it is equally suitable for use in low volume sprayers applying 1 lb. in 10 gal. of water per acre or in air-atomised mist blowers using 1 lb. in 1 gal. of water per acre. Hitherto such low volume application has had to be made with emulsions or solutions. This preparation makes it possible to use the more efficient solid suspension principle.

When tested biologically the micro-crystalline paste lies between the finest quality wettable powders and emulsions. If a test is carried out on glass or other non-porous surface, it will be found that the wettable powder is significantly superior to the paste or emulsions. When tests are made on porous surfaces, such as plaster or filter paper, differences between the wettable powder and the paste are not significant but both products are markedly superior to emulsion. In all cases all preparations are superior to kerosene solutions.

It has been found that on a porous surface of fine texture, the incorporation of an extra wetting agent improves the efficiency of the deposit. Presumably this assists the removal of the emulsifying agent which tends to make the crystals of DDT adhere to the surface too firmly. Apart from its value in normal and low volume spraying operations, the paste formulation has shown a marked advantage in the treatment of fabrics. This is believed to be due to the entangling of the crystals in the fibres. Two applications of this have been developed. Firstly, sacks containing grain are sprayed to protect the contents against insects such as Calandra or Tribolium. This method has been adopted on a wide scale for the protection of groundnuts in storage with remarkable success. The second application is the treatment of sheets or blankets as a protection against bedbugs. In this case 1 lb. of paste in 20 gal. of water is used in place of the last rinsing water. Sheets retain their activity to bedbugs even after two subsequent washes and ironing.

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Wider Olive Tree Spacing Advised

Nowadays, reports *The Countryman*, Cyprus's farming journal, there is a growing tendency to establish small olive groves in arable land and in these new plantations trees are often seen planted very closely together. When planning on new plantings it is as well to remember that olives do not seem to like to be too crowded.

It has been noticed that the trees situated in the outside of a group give the best yields. In a carefully controlled trial in California it has been shown that wide spacing (44 ft. by 44 ft.) gave a much higher yield per tree and per unit area than did close planting (30 ft. by 30 ft.).

Over a period of five years the yield per unit area from the wide-spaced trees was 77% more per tree and 52% more per unit area. In years of poor yield this difference was even more striking, while fairly good yields were obtained from the widely-spaced trees the yield from closely-planted trees was so low as to be almost a complete failure.

The European Farm Machinery Situation

In response to requests from member countries, FAO carried out an inquiry on the farm machinery situation in 1949 in Europe, submitting the results to the respective governments for revision and amplification. The purpose of the survey was to furnish basic material on the use of farm machines and on background conditions determining the extent of and the trends in the development of farm mechanisation in Europe. From the report the following account has been condensed.

IN most European countries the use of modern farm machinery is more or less connected with the development of industrial areas or trade centres. Hot spots of industrial and trade development can be identified with higher purchasing power and greater mechanical service facilities for the surrounding agricultural areas, both essential prerequisites for the success of farm mechanisation. The development of farm mechanisation in Europe further depends on the availability of man power and the scale of wages for farm labourers, on the size and general layout of the farms, the farming system, the service facilities, etc. The density of the farm population itself has no great bearing on the progress of mechanisation. Only in countries where a high percentage of the total population is engaged in agriculture and where the surplus of farm labourers cannot be absorbed by industries and other professions, general mechanisation does not appear to be justified.

In northern and central European countries, where there is a lack of man-power, mechanisation in agriculture is making rapid progress. Thus in the U.K. and in France, where the agricultural population is comparatively scarce, the lack of rural workers makes it necessary to utilise mechanical means as much as possible. The same applies to some of the densely populated industrial areas in Belgium, Germany, the Netherlands and Switzerland, where the use of power machines and equipment is economical even for relatively small farm units. On the other hand, in regions around the Mediterranean, where the surplus of the rural population cannot be sufficiently absorbed by industry, the advisability of measures for the increase of man-power by labour-saving machines is rather dubious, because it means increasing the unemployment of farm labourers. Northern and insular Italy should be mentioned in this connection, as well as Portugal and some countries in south-eastern Europe.

Farm shapes and sizes

The majority of farms in Europe are family farms of small size averaging between 6 to 12 ha. on the Continent, and about 30 ha. in the United Kingdom (1 hectare—2.47 acres). These average sizes vary in the different regions according to the density of the population, according to soil and climatic conditions, methods of farming, etc. In densely populated rural areas, where land is scarce, farm holdings are frequently split up into narrow and scattered plots. The splitting up of holdings is aggravated by co-inheritance, *i.e.* by the free division of holdings among the heirs in practice in most west and south European countries. The scattered layout of holdings is a great handicap for the sound progress of farm mechanisation. The application of laws for the re-grouping of holdings and for establishing smallest admissible farm units, affording a living to the farmer and his family, is under way in many countries.

Soil and climate

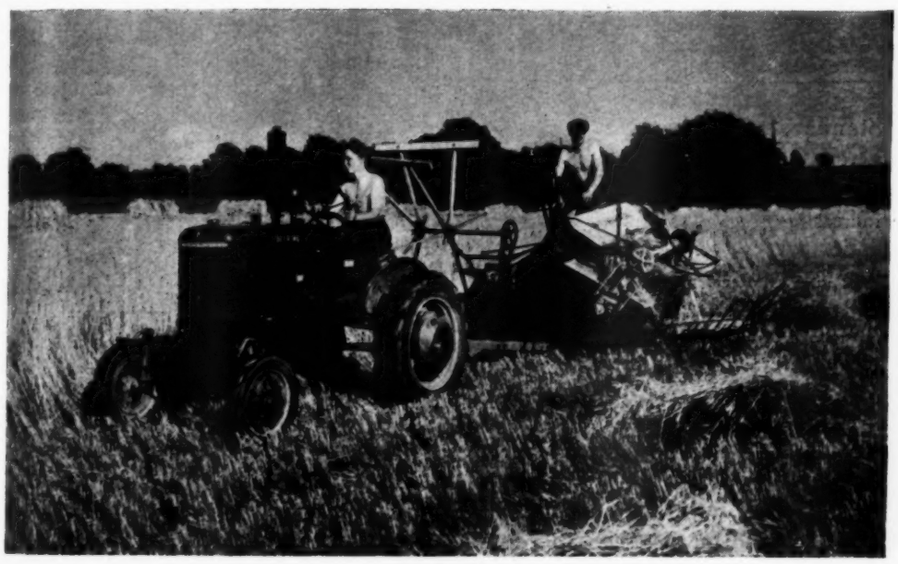
In Europe one can broadly distinguish three different zones with more or less similar soil and climatic conditions: the northern and central European zone, the alpine area and the Mediterranean area. Each of these areas has different needs as to the type of farm (especially tillage) machinery utilised. The northern and central areas with abundant rainfall, snow and frost during the winter, necessitate soil preparation in autumn and spring. Their soils are more or less moderately compact. In northern and central Europe more rapid progress has been made in the past in the development of modern agricultural machines and implements and these were introduced into other parts of Europe, for which they were not always adapted. The mountain areas which have similar climatic conditions to those of the north, though more extreme, have serious problems resulting from the hard work on steep slopes. More and more attention is being devoted to special machinery to facilitate work on hilly land. For the south dry summer periods are characteristic and it is necessary to work the soil in summer after the harvest when it is very compact, so as to collect moisture during the rainy periods. In southern regions special tillage implements are being developed for the particular climatic conditions.

Why mechanise?

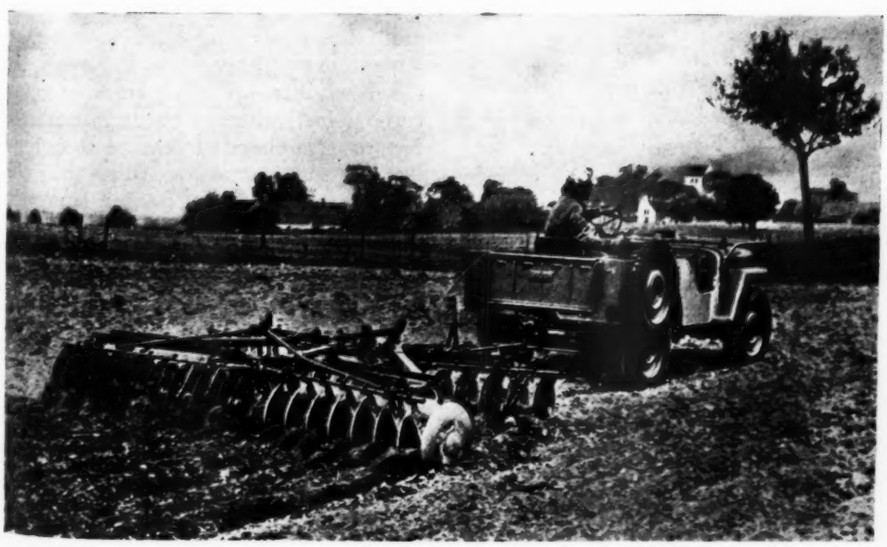
One of the main objectives of mechanisation in Europe is to provide small and medium family farms with suitable power machinery and modern equipment. The whole structure of European agriculture is essentially based on small and medium farmers, who socially and morally form the soundest part of the European population. As all available cultivable land in Europe is used for production, no new arable land can be added by mechanisation. Large estates have already been mechanised in the past and a great number of them have been divided by land reforms of the post-war period, with a view to helping small farmers in need of land.

Lack of available space in densely populated regions is the reason for the overwhelming majority of small and medium farms in Europe, and for the necessity of utilising to the very utmost every available bit of arable land. Thus mechanisation in Europe has to cope with one great difficulty, a difficulty unknown and often not sufficiently realised in zones where plenty of land is available, *i.e.* the increase of man-power efficiency, limited to the small and medium farm space and to the necessity of maintaining diversified crop farming with well adapted rotation systems so as to keep yields as high as possible. Hence all efforts in Europe tend first to adapt the machines to the existing farm structure and, secondly, to adapt the farms to the machines used. With this in view, the fundamental objects of farm mechanisation

Construction of a forest road in France with the aid of heavy equipment



Mechanised harvesting in Scania, Sweden



The use of a jeep in Denmark as a substitute for tractor or horse

in Europe are: production of a maximum amount of food at the lowest possible cost without depleting the soil, better cultivation, performance of timely work, freeing land from growing horse feed, reduction of weather risk, one-man control of power unit and equipment, speed in transport, etc. All these factors weigh on the mind of the European farmer. When buying a tractor, very few farmers make financial calculations regarding the capital investment and interest; they simply buy a tractor in order to cope with the work which has to be done, when it cannot be done with the available man-power or when the latter is too expensive.

Use of machines on farms

The war left Europe with comparatively low losses of agricultural tractors, but with greatly diminished animal draft power. To fill the gap in animal draft power importation and home production of tractors was greatly favoured and partly financed by aid from overseas during the immediate post-war period. This period, with its high prices for agricultural products and the need for a rapid recovery in local food production, favoured widespread use of power machinery in Europe and paid its expenses. In the meantime shortage of labour and the increased wages for man-power in most European countries with well developed industry have led to even further mechanisation. More recently, however, *i.e.* with the return to normal of food supply conditions and with the decrease of prices for agricultural products, it has become evident that the majority of European farmers with small holdings can only afford limited expenditure for farm machines and cannot afford to have certain machines even if they are of vital importance for the efficient management of their farms. The European tractor inventory has greatly increased in the course of the last few years. Table 1 overleaf shows an estimate of the tractor inventory in Europe for the year 1949/50 compared with the pre-war inventory.

On many farms in Europe a medium power tractor can give the true benefit of mechanisation. It is generally assumed in Europe that, when substituting horses with a tractor, a threefold increase of the workers' output can be achieved. However, where tillage is concerned, a tractor generally ploughs more than three times as much as a pair of horses in a day.

The average number of hours during which a tractor is used on a farm varies widely, according to the type of farming,

from 600 to 1,200 hours a year. On small farms the number of hours of useful employment of tractors has been increased by the introduction of new branches of production. At the same time, on the majority of small farms careful driving and good maintenance by the owner have prolonged the average useful life of the tractors. There is a general tendency to use more and more diesel tractors in Europe for field work, whereas for work to be performed on the farm itself, electrification is increasingly favoured. The use of small two-wheel tractors, very much encouraged during the last few years, has proved very successful in regions with predominant grassland production, such as Switzerland, which has long experience in the construction of small two-wheel tractors.

Production and trade

As a consequence of the great demand for power and other farm machinery during the first post-war years, some of the European countries increased their production capacity, particularly that of tractors, to an extent which exceeded the normal possibilities of absorption in agriculture. Thus the tractor production capacity in the U.K. increased enormously (about 130,000 in 1948/49), was restored in the Soviet Union (production in 1949 estimated at 70,000-80,000 tractors), increased in Germany (20,000 tractors produced in 1949), France (17,000 tractors produced in 1949), Czechoslovakia (10,000), Italy (6,000), Sweden (6,000) and Hungary (3,000 tractors). Countries which formerly did not produce tractors have begun to do so, Austria producing about 4,500, Poland about 2,000, etc.

As a consequence some of the main tractor factories in Europe already had difficulties in selling their products in 1949 and were obliged to reduce their output. The situation since 1949 has, however, improved, particularly in the United Kingdom where the sterling devaluation made it possible for British manufacturers to compete on the international market.

As far as trade is concerned, the various trade barriers and currency difficulties have not facilitated the flow of farm machines among the various European countries until 1949. The ERP greatly facilitated the import of farm machines into many Western countries, which otherwise could not have purchased them. Since the end of 1949 the farm machinery market has recovered and sales are increasing again and are effectuated chiefly in connection with the various bi-lateral trade agreements.

TABLE 1
TRACTOR INVENTORY IN EUROPE IN 1949/50 COMPARED WITH 1939

(Numbers in thousands)

Country	1939	1949/50
Austria	2	12
Belgium	1	5
Bulgaria	4	6
Czechoslovakia	6	27
Denmark	5	13
Finland	4	9
France	33	137
Western Germany	35	110
Eastern Germany	36	28
Greece	2	4
Hungary	7	14
Iceland	—	1
Ireland	4	10
Italy	33	55
Luxembourg	—	1
Netherlands	5	13
Norway	3	10
Poland	13	16
Portugal	1	2
Rumania	3	6
Spain	10	9
Sweden	10	52
Switzerland	8	25
Turkey	1	5
U.K.	53	292
U.S.S.R.	523	500
Yugoslavia	4	8

Standardisation problems

With the prevalence of small and medium sized farms there is an ever-increasing need to limit the present variety of production in farm machines to a reduced number of types of each kind and to make it possible that tractor equipment of different origin should be interchangeable for tractors of different makes. A need for standardisation is felt in most European countries and national standardisation committees for farm machinery have been formed in practically all of these countries, but their endeavours on a national basis do not present a solution of the problem unless international co-operation is assured in this field.

At the suggestion of FAO the International Commission of Agricultural Engineering (CIGR) is studying agricultural standards for tractors and is collaborating for this purpose with the International Standards Organisation (ISO) to achieve an international liaison and effective co-operation for the adoption of international standards.

Finance

Different criteria are followed in the various countries to facilitate farm machinery purchases. Subsidies are generally restricted to special machines of public utility (machines for reclamation works, sprayers, etc.), for co-operative use or for contract work on large areas. Credit facilities are granted in some countries in connection with ERP or other aid for the purchase of different kinds of machines by co-operatives and also by individuals, if they present sufficient guarantees. On the whole, it is only in a few countries that farmers enjoy credit facilities for the purchase of machines at reasonable terms, although such facilities would be of great help to them in obtaining the necessary machines. It does not appear that credit facilities present any great risks to the lending institutions, pre-war experience having shown very satisfactory results in different countries.

Fuel situation

Most European countries depend entirely on imports of fuel to provide for their internal demand. Importing countries generally charge comparatively high taxes for the consumption of motor fuel which usually exceed the original price paid for the fuel on its entry into the country. In some countries, however, reductions or refunds of these taxes are granted for certain kinds of fuel, if it is destined for agricultural purposes. The fuel tax policy ruling these reductions or exemptions considerably influences the development of mechanisation in the respective countries. This policy determines to a certain extent not only the kinds of engines used for agricultural tractors, but also the limits of economical tractor utilisation. Stability in the amount of tax imposed and in the kinds of fuel favoured are prerequisites for sound progress in the use of engines for agriculture. Unfortunately some European countries in the course of the last few years changed not only their taxes on fuel, but also the kinds of fuel favoured, which caused a lot of trouble not only to the farmers but also to the manufacturers of agricultural tractors. Thus, for example, one country formerly exempted diesel oil from taxation for agricultural purposes, which induced manufacturers to build and farmers to buy preferably diesel tractors. Now, in the same country, heavier tax is levied on diesel oil than on other kinds of agricultural fuel, with the result that manufacturers are obliged to change their production, while farmers are using their old diesel tractors at great expense. However, such exceptions do not affect the general tendency in Europe to obtain increasing tax facilities for diesel oil used for agricultural purposes.

Taking into account the average price difference between gasoline and diesel oil, the cost of running tractors with gasoline is about three times that of the tax-facilitated diesel oil.

Most European farmers prefer to pay the higher initial cost for the purchase of a diesel tractor in order to have smaller

Combine harvesting barley in Germany. Note the tractor and heavy trailer used for carrying away the filled sacks

current expenses when running their tractors, if these are used for more than 500 hours per annum.

If smaller diesel engines under 11 h.p. are not yet being used for agricultural purposes in Europe, the reason is that their yearly utilisation is not sufficient to justify their higher purchase cost as compared to that of gasoline engines and that they are more difficult to start than gasoline engines.

Maintenance and repair services

The organisation of these services has made much progress in most European countries in the last few years, but in many regions could still be considerably improved. The situation with regard to spare parts, which was extremely difficult in the first post-war years, has become normal again, as many countries have started producing their own spare parts, or have been able to obtain the necessary supply, or because some obsolete type of machine has in the meantime been abolished. Nevertheless, most European farmers complain of the heavy expense of any kind of repair which they cannot perform themselves.

Machinery testing

Tractors and other farm machines are tested in most European countries. Many national testing stations have developed their own testing methods, but, unfortunately, the testing methods of the different stations vary considerably, so that it is not possible to draw comparisons between the different testing results.

With the ever-increasing cultural and trade relations between different countries, the need for uniform testing methods has become very pressing, particularly for tractors. At the suggestion of FAO the International Commission of Agricultural Engineering has started an international enquiry on the methods and apparatus used by the different stations for tractor testing, with a view to obtaining a basis for the development of uniform tractor testing methods to be internationally adopted.

There are a number of farm machinery institutes in Europe, most of which are attached to universities and some to manufacturing firms. Many of these institutes carry out research work, but only few of them have the necessary financial means and equipment for the thorough study of technical development problems. Some countries have a considerable number of agricultural engineering institutes which are exclusively devoted to teaching. A certain concentration of institutes, by which their number would be reduced, their equipment improved and their staff increased would, perhaps, in some countries, lead to greater activity at practically the same expense. With regard to the collaboration among different research institutes, the International Commission for Agricultural Engineering is predestined to become a forum for co-operation between agricultural engineering research workers of different countries for the study of common technical problems to be solved.

Outlook

An increase in agricultural production of at least 15% compared with 1938 is aimed at in most European countries in order to meet the needs of the growing population. One of the most important conditions for attaining this aim is the progress of mechanisation on small and medium sized farms. There are still large possibilities for further mechanisation, but the purchasing capacity of the farmers has diminished during the last years and this might temporarily slow down its further progress. In order to remove some of the obstacles which are in the way of further mechanisation, certain problems connected with the possibility of more efficient utilisation of farm machines have to be solved in some countries, a few of which might be outlined as follows:—

1. Re-groupment of holdings with the creation and safeguard of economic farm units.

2. Expansion of joint farm machinery utilisation.

3. Development of adequate credit facilities for financing farm machinery purchases.

4. Standardisation of tractors and equipment devices assuring the interchangeability of tractors and equipment of different makes.

5. Limitation of number of types of machines of widespread use in order to allow their mass production at reduced prices and to assure the possibility of easier and quicker repair services.

6. Development of machinery which, under special climatic conditions, does not destroy the productive capacity of the soil.

7. Reduction or remission of fuel taxes —if possible uniform fuel tax policies and stability as to the kinds of fuel favoured for agricultural purposes.

8. Unification of tractor-testing methods.

9. Co-ordination of research among agricultural engineering institutes of various countries.

Photos: p. 437 (centre), Swedish Travel Bureau; p. 437 (top), French Embassy; p. 437 (bottom), Danish Embassy; p. 439, Massey Harris.

The Future of FAO

THE sixth session of the 1951 Conference of FAO or, to give its full title, the Food and Agriculture Organisation of the United Nations, which will be held in Rome from November 19 to December 7 next, bids fair to be among the most important in its history, for at it will be examined the report of the Working Party appointed by the Council to examine the programme of work and the associated long-term problems of FAO as a whole.

The report has been printed and published and in view of the importance of the issues at stake and the weight which must necessarily attach to its findings, it merits more than passing mention.

It is now over five years since FAO was established as the result of the recommendations of the Hot Springs Conference in 1945. The original concept of a mondial organisation which would help to raise levels of nutrition and standards of agricultural production went far beyond the activities of previously existing international bodies such as the League of Nations or the International Institute of Agriculture. It is almost staggering in its implications and it is small wonder that after five years' experience many directions should reveal themselves in which modifications of the original programmes are needed if the organisation should in reasonable measure fulfil the aims and aspirations which underlay its original conception.

Obviously any restatement of objectives and programmes can only be effective if it is preluded by intensive study of all aspects and this the Working Party's programme provides.

As a guide the Council laid down certain fundamental points. These are summarised as follows : (a) the degree to which the work of the organisation could safely be decentralised; (b) the extent to which universities and research institutions in the member countries can be made use of in the programmes; (c) the manner in which activities could best be planned to secure maximum co-ordination with other bodies of the United Nations, *e.g.* the regional commissions and other specialised agencies; (d) the collection of information from member countries and the use of the material so collected; and (e) the relative importance to be given to the activities of FAO in different fields.

The Working Party, through the Director-General of FAO, circularised all member countries on these lines. It is perhaps significant that the 29 countries from which replies were received only represented less than half of those to which the enquiry was addressed.

Probably the most essential point for the success of such an organisation is the comprehension and acceptance of its functions and limitations by its members. These roughly are of a threefold nature:

1. To serve as an international forum in which policies and problems in agriculture and its related activities can be ventilated and discussed.

2. To serve as a repository of information on all aspects of the many subjects related to agriculture and agricultural development which can be drawn upon as needed, and to disseminate essential new information as effectively and speedily as possible.

3. To furnish advice and guidance to member governments on the solution of the problems with which they are confronted.

4. To supply technical assistance to member governments in the practical solution of their problems in so far as the resources of the organisation permits.

The organisation itself possesses no direct administrative powers; it can only operate through the administrative machinery of the member states.

Success obviously must depend on the esteem and confidence with which it is regarded by its members. If this is not forthcoming in full measure it cannot hope to succeed. Actually, the comparatively small response which the circular evoked would seem to indicate that there may be something to be desired in this direction at present.

Furthermore, its effectiveness must also be determined by the resources it can command in the way of qualified staff and facilities; this in turn depends on the size of the available resources, and as these are entirely derived from subscriptions from members, their amount will be directly proportionate to the value which the member countries attach to its services. There is therefore an essential linkage between the activities of the organisation and the related activities of the member countries; these must be active and fluid.

Under the present organisation this is provided by direct contact with member governments and by national FAO committees, although it is not clear from the report to what extent the latter form of organisation is generalised.

One recommendation in the report that seems of importance is that the central office should issue periodical news letters which would enable members to assess the activities of FAO over the whole field they cover. This should assist appreciation of the value and potentialities of FAO as a whole. The Working Party considered that national committees constitute the most effective means of establishing contact with FAO. No doubt they are right, but much will depend on the standing and esteem which those committees possess in the countries themselves.

This point will no doubt be powerfully affected by the proposals which the Working Party make for some decentralisation of FAO activities ardently desired by some member countries.

The path is a difficult one to tread and the Council have to choose between the Scylla of over-centralisation and the Charybdis of apparent over-concern with purely domestic matters in member countries.

One point which is brought out clearly in the report and the appendices is the defects which have resulted from over-insistence on international conferences. That conferences of this sort must be held is inevitable, but frequently attendances are so large and the topics which must be crowded into a short time are so numerous that it is impossible for anything very concrete to emerge. The report favours, and we think quite rightly, more frequent regional conferences and the restriction of the numbers of international gatherings.

An outstanding consideration which of necessity affects the standing and prestige of FAO is the relatively enormous number of bodies on an international footing which deal with related problems in the same field. The Working Party stress that the responsibilities of the various organisations should be clearly defined and duplication avoided while maximum collaboration should be secured. They plead, perhaps somewhat plaintively, that FAO itself should also enjoy compensating collaboration and recognition from the other bodies concerned.

In dealing with the programmes of work the report emphasises certain principles which must be observed, *viz.*, that (a) priority must be given to increasing food supplies, (b) that priority must be given to projects likely to be useful to a large number of countries, and (c) that priority must be given to projects which are likely to prove most beneficial, *i.e.* in underdeveloped countries.

It also emphasises the need for some reorientation of the activities of some of

the divisions of the Organisation where it is stated the Working Party are not satisfied that in all cases there has been adequate allocation of responsibilities nor effective collaboration between different divisions concerned with different aspects of related subjects.

In concluding their report the Working Party emphasise that in the final resort the success of FAO will be commensurate with the strength of its staff. They insist quite rightly that it is important to avoid the conception of FAO as a purely administative machine. It has a dual function, first as a World Parliament for food and agriculture, and second as a secretariat to implement the recommendations which its member nations make.

With this one can strongly agree, with the addition that its success will also depend on the manner in which its activities are organised and the support which it can command from its members. It already has behind it a substantial measure of achievement and it is most desirable that the world should be told of what it has done and what it can do, for in the last resort it holds true of FAO as of everything else ' by their works shall ye know them.'

New Swedish Agricultural Laboratory

Swedish agricultural science has received a new centre of advanced research with the inauguration in July of the State laboratory at Svalöv, adjacent to the Swedish experimental farm of the same name, well known the world over especially through the plant improvement experiments of the late Professor Sven Nilsson Ehle.

The new laboratory consists of a chemical and biological department. The most valuable apparatus in the chemical laboratory, *e.g.* polarimetric, photometric and spectrometric instruments, are kept in a constant-temperature room, while the water-analysis department prides itself on having a capacity of 1,900 tests per day. The biological laboratory contains, *inter alia*, localities for pathological plant experiments, chromosome experiments, freezing and thermostatically - controlled rooms. There are also hothouses for special plant-breeding experiments as well as departments for theoretical research in methods of plant improvement with artificially-induced mutations.

The Swedish plant-breeding station at Svalöv has long been collaborating extensively with foreign institutions. In order to facilitate this co-operation the new laboratory has been provided with a number of research rooms specially intended for visiting foreign scientists.

(Photo above)

A small swarm of desert locusts flying past Rumuruti, Kenya, in 1945. The swarm was weighed photographically and amounted to about a ton per acre

Recent Advances in Locust Research

Dr. B. P. UVAROV, C.M.G., F.R.S.

Director, Anti-Locust Research Centre

The following authoritative article is a condensed version of a paper read before the British Association's annual meeting last year. The depredations of locusts in Africa and the Middle East are a major menace, and this account of the progress which is steadily being made against this pest will keep readers up to date with developments. It is reproduced by permission of the author and also the secretary of the British Association.

ALTHOUGH locusts are amongst the oldest enemies of mankind, research work on the locust problem has always been intermittent and more continuous and systematic studies did not commence until some 20 years ago. At that time, a great locust plague threatened Africa and western Asia, and this made several governments, including the British, realise the need for investigating not merely the best means of killing locusts, but also the reasons for their periodic swarming, resulting in periodical economic catastrophes. In this country a small section of the Imperial (now Commonwealth) Institute of Entomology was given the task of organising, collecting and analysing data on locusts in Africa and western Asia, and this led to the establishment, in 1945, of the Anti-Locust Research Centre, an institution with an extensive programme of research into all aspects of the locust problem. The French Government also created a Committee for the Study of Locust Biology; in India a special organisation was set up for research, and in Egypt a Locust Section of the Ministry of Agriculture was created; in South Africa research at the University of Pretoria was already in progress.

International co-operation

An important feature of the work, especially during the period 1930-38, was a very high degree of international co-operation in locust research. That this has been achieved was due, at least partly, to the existence of the Anti-Locust Re-

search Centre which served to stimulate co-ordinated investigations in many countries, while it also played a prominent part in the organisation of five successive international conferences. At these conferences common problems were discussed by experts of many nations, research programmes were prepared and the work shared out. Important researches have been carried out by individual countries, amongst which India, Egypt, France, Belgium, Italy and South Africa have been particularly active.

The first point which it was necessary to clear up was, primarily, a geographical one. It had been known that tropical Africa was subject to plagues of three different species of locusts: Desert locust (*Schistocerca gregaria* Forsk.), African migratory locust (*Locusta migratoria migratorioides* R. & F.) and red locust (*Nomadacris septemfasciata* Serv.). Most of the old records of swarms in Africa, however, referred merely to 'locusts' and it was impossible to disentangle the evidence referring to each species separately. Several international conferences agreed that all locust reports from Africa should be sent to the Anti-Locust Research Centre, with full data as to the species, stage of development, direction of swarm movement, etc., according to a standard form. This was a great step forward. Tens of thousands of reports had to be dealt with, but the results fully repaid the effort. Within some two to three years it became clear that each of the three main African locusts has its own invasion area, although they partly overlap, and in the past this has been a source of confusion.

When sufficient data had been accumulated, it was possible not merely to follow the developments, but to analyse them with a view to establishing the normal annual cycle of each locust in every part of its geographical area. These normal cycles proved to be correlated with local climates, and thus studies on locusts had to be closely linked up with climatology. In each climatic area the seasonal cycle of locust breeding proved to have a definite pattern, mainly dependent on rainfall, while migrations of swarms between breeding periods showed definite seasonal trends, largely connected with wind systems. This knowledge has made it possible to forecast locust breeding and movements of swarms.

Influence of weather

As a result, monthly forecasts are now regularly issued by the Anti-Locust Research Centre, and it is a notable achievement that now no country in Africa and western Asia need be in fear of an unexpected invasion—warnings of impending danger are usually given well beforehand.

When purely cartographic work had shown close dependence of locust migrations on weather, the next step was to investigate, by direct observations, which weather factors affect locust flight. Field research parties, equipped with modern meteorological instruments have been carrying out such observations in East Africa. This work is still in progress, but there are already some valuable findings. Sunshine, for instance, proved to have a profound effect on flying activity, locusts being able to fly in sunshine at air temperatures which would otherwise immobilise them. The height at which swarms fly may reach many thousands of feet above the ground, and this is related to the intensity of thermal convection currents which develop over heated ground and provide a lift to locusts as they do to soaring birds and gliders. Winds have a particularly strong influence on horizontal displacements of swarms, leading to invasions. It has often been asked whether locusts fly with the wind, or against it. An objective study showed that there is no simple answer. Normally, a locust takes off into the wind, but its flying speed is about 11 miles per hour, and if the wind is stronger than this, the locust will be carried by it, although its own course may be a different one. In light winds there is a tendency to fly against, or across, the wind and the general direction of displacement, *i.e.* of migration, will vary accordingly. All details of this balance between an actively flying locust and a moving medium of the air are not yet sufficiently known, but it is clear that the problem requires a combined investigation by biologists and meteorologists. On the biological side, the locust's responses to weather factors are of obvious importance.

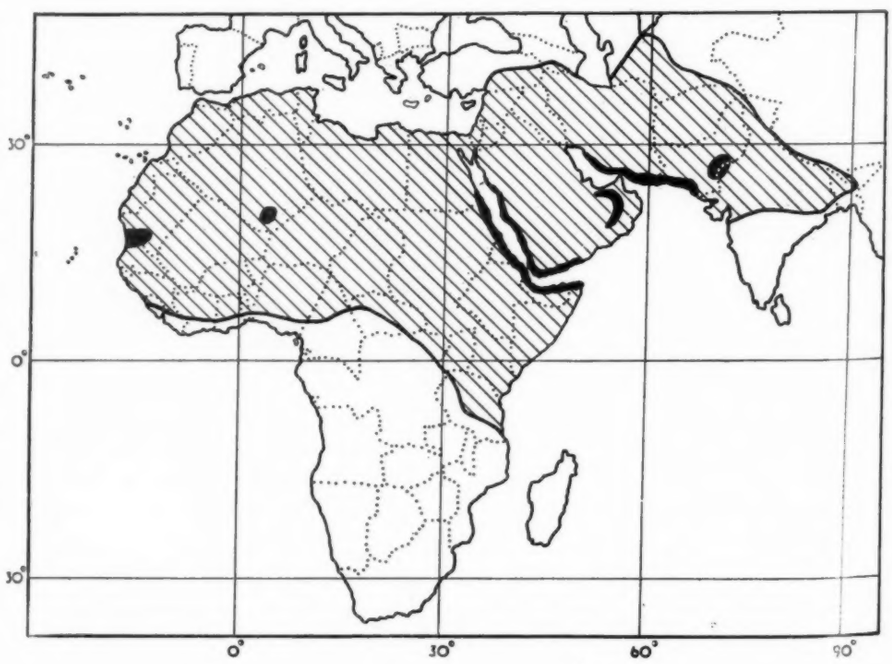
In this connection, an interesting discovery has recently been made of a special organ, consisting of hair patches on the head of a locust, which enables the locust to perceive air currents and stimulate it to take off into the wind.

Another important physiological aspect of long-range migrations is the source of energy, and laboratory work is in progress to study the utilisation of reserve substances by suspended locusts made to fly for long periods.

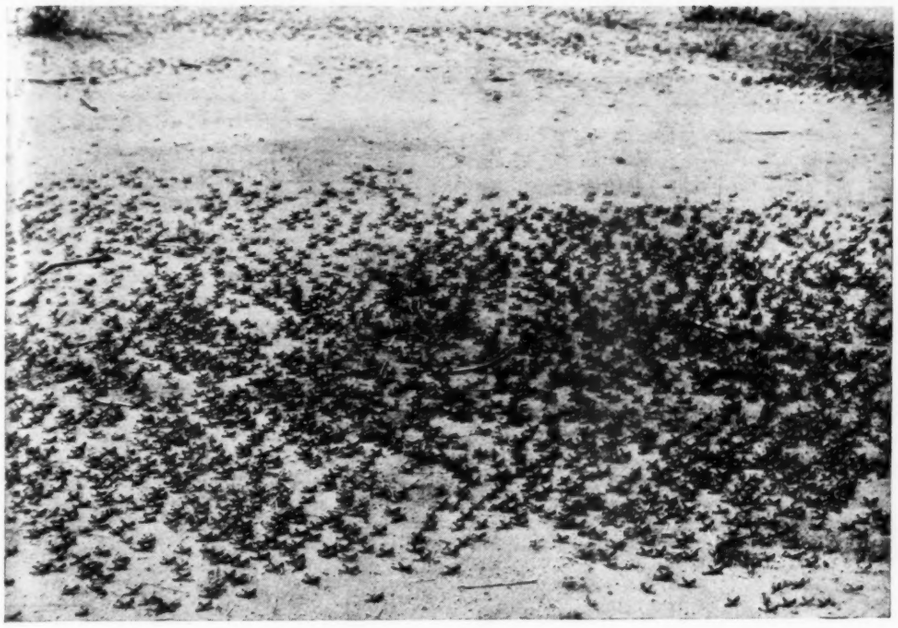
Parallel with this work, research is being carried out on the aerodynamics of locust flight, and the general result of all these studies should be a better understanding of details of connection between locust migrations and weather; this will provide a sound basis for both long- and short-range forecasting of swarm movements, which is important in organising control. In any case, the problem of migrations of locust swarms, which sometimes travel for hundreds of miles, is being gradually unravelled.

Marching hoppers

Another striking feature of locust biology which has also been regarded as mysterious, is the mass marching of young locusts, or



The locust area of Africa and Asia ; known areas of origin of swarms coloured black



Desert locust hoppers on the march, Kenya, 1945

hoppers, as they are called. Bands of hoppers, consisting of millions of individuals, are known to march in dense formation, by-passing some obstacles, overcoming others and suddenly invading crops. Recent studies and experiments, both in the field and in the laboratory, have shown that marching activity of hoppers, like the flight of swarms, is affected by temperature, sunshine and wind. Marching is, to some extent, stimulated by hunger, but there is no reason to believe, as has been thought in the past, that hoppers march in search of food; in fact, hopper bands often march away from good vegetation into the desert.

An important part in these mass movements is played by the optical responses of hoppers. Thus, the coherence of a marching band is due to visual inter-attraction of hoppers, while the unanimity of the direction of march is a result of optical compensation reaction; images of neighbouring hoppers marching forward move across the eye of a stationary hopper, and the hopper stabilises the images by moving in the same direction. A subsidiary orientating influence is provided by a reaction to the sun; it has been shown that a band marching with the sun shining on it from one side, will turn about if it is shaded and a reflection of sun is made to shine on it from the opposite side. Since marching hoppers, as we shall see later, usually have a large amount of black in their coloration, they are liable to be very strongly heated by direct sunshine, and heating of their bodies increases their marching activity. With a fall in air temperature and the sun setting, bands usually stop for the night, to resume their march next morning. Hopper behaviour in the morning is interesting as showing their dependence on radiant heat from the sun. If the morning is cool, hoppers are quite immobile, but the first rays of the sun falling on them cause some slight movement and soon clusters of hoppers are seen on the best lit spots, all sitting with their sides perpendicular to the rays of the sun—they are basking. As the sun grows hotter, the orientation of hoppers changes—now they sit facing the sun, and thus exposing to its rays the minimum surface. After this, marching begins. Thus, observations on hopper behaviour in the field showed the need for fundamental studies on their vision, on possible thermoreceptors, etc., and these studies are in progress.

Feeding

Of course, an important feature of locust biology is feeding. Their voracity is proverbial, but this is an impression based rather on their occurrence in vast numbers than on the amount of food taken by individuals, a problem which is being investigated now. It is not true, either, that locusts will eat anything; in fact, different species of locusts have their favourite food plants, and some plants are not eaten at all.

Cartographical studies

Apart from providing basic information on migrations and seasonal cycles, the cartographic approach to the locust problem has resulted in another important advance. When breeding areas and swarm movements of a locust species have been plotted for a whole period of its swarming, extending for several years, it was seen that a locust plague usually commences in a restricted area, spreads from it gradually to the maximum and then dies down.

Cartographical studies could, of course, supply no more than a general indication of the sources of locust plagues, but they made it possible to concentrate the search for these sources. A number of entomologists of various nations—French, British, Belgian, Egyptian, Indian and South African—undertook arduous journeys to explore the suspected areas, and investigate the conditions which make these areas particularly favourable for the formation of initial swarms. By that time it was already known that every locust may occur in two very distinct phases; the solitary and the gregarious (or swarming) and the initial search was particularly directed towards finding out the distribution of locusts in the solitary phase. Soon, however, it became clear that not all areas inhabited by solitary locusts should be regarded with suspicion, but only those where transformation into gregarious phase had been observed, or its possibility suspected from other evidence.

Phase changes

Laboratory work on phases provided clear indications that phase change occurs in connection with hopper density. Hoppers reared in isolation are characterised by mostly uniform coloration, very often green, but with considerable individual differences; those reared in crowds are remarkably similar to each other, bearing a bold pattern in which black and yellow (or orange) colours, predominate. Adults of the phylum *gregaria* are less strikingly different from those of *solitaria* in coloration, except in connection with sexual maturation when they develop yellow pigmentation, particularly bright in males, whereas solitary adults show no maturation changes. On the other hand, there are considerable morphological differences between adults of the two phases; some of these differences are so obvious, that locusts of the extreme phases have been mistaken in the past for different species, while others are discoverable by exact measurements and calculation of ratios between parts of the body, and their statistical analysis. Since locusts of one phase can be transformed into the other experimentally, it is only natural to expect that the extremes are connected by a continuous series of transitional forms.

The laboratory evidence that phase change is connected with population den-

sity has been used in the field investigations directed towards discovery of the sources of locust plagues, or of outbreak areas as they came to be called. The question as to how the density of a population of solitary locusts can increase to the level necessary to cause phase transformation is not a simple one. A mere increase in numbers of locuts, if they were evenly distributed over a uniform area, could hardly bring about the required crowded conditions. Two factors, however, tend to assist in the process. The first is a considerable sensitivity of locusts, both hoppers and adults, to environmental conditions, resulting in movements from habitat to habitat, and this may lead to concentration. For instance, females of Desert Locust lay eggs in damp sand; if a shower of rain is followed by a dry spell, there will soon be only some spots still remaining suitable for laying and locusts will lay in them. Thus eggs may become somewhat localised and the hoppers that hatch a couple of weeks later will be found in more or less dense patches. These hoppers usually feed on small ephemeral plants which spring up in the desert after a shower; they soon dry up, thus depriving hoppers not only of food, but also of shelter.

Although marching of hoppers, characteristic of the gregarious phase, is not conspicuous in the solitary hoppers, the latter, nevertheless, tend to wander, particularly when stimulated by sunshine, temperature and wind. In their random wanderings, some reach denser vegetation, not yet burnt up by the sun, where the stimuli for movement are reduced. The result would be a concentration of hoppers, and it all depends on the numbers available in the area and on the relative size of the concentrating patches, whether the critical density would be reached.

Mutual influences

Hoppers in such concentrations resulting from random movements are subject to mutual influence, due possibly to visual inter-attraction which develops as a result of close association. They now tend to keep together and begin to march in groups; small groups meeting each other often fuse and larger hopper bands are formed.

The locust side of the problem requires very detailed laboratory experiments on behaviour, since there is already some evidence that a change in the behaviour of a solitary hopper can be induced by placing it in a crowd of gregarious ones, when it proceeds to march. The problems of inter-attraction and of mutual stimulation demand serious attention.

Locust density

While the dynamics of locust outbreaks are presented above mainly as a result of concentration due to ecological factors, the available initial population of locusts is obviously also of importance. It is also important to be able to follow changes in density during the initial stages of an outbreak and to analyse them quantitatively. The main difficulty in this work is that of the method of estimating the number of locusts in a given uniform area. Low density and rather inactive habits of solitary hoppers make direct counting unreliable, and this is even more so in the case of adult locusts which may be wary and conspicuous in hot weather and hiding in grass when it is cool.

Defence of standing crops against locust invasions is relatively simple from the technical point of view. Powerful new synthetic insecticides provide the means of killing locusts at a small cost and without any risk to livestock or to plants. The application of insecticides is being mechanised, which makes it more economical, both in the chemicals and in labour and, although no perfect machinery exists to suit special requirements of locust control, it is only a matter of time until the necessary further improvements in the technique of locust killing are achieved.

Migration forecasts

To be able to kill locusts in a given well-defended area is, however, not the same thing as to control a plague. Swarm migrations extend over hundreds of miles and breeding areas are not the same from season to season. Swarms produced, for instance, in Arabia are a menace to the whole Middle East and to eastern Africa; swarms produced in summer in West Africa invade North Africa and breed there in spring, their progeny flying back to the tropics. An essential condition of successful control of a widespread plague is a careful overall planning, so that control units are ready in all the right places at the right time. Planning of large campaigns, as for instance against the Desert Locust whose invasion area covers half of Africa, the Middle East and the Indian sub-continent, would be useless without willing co-operation of the many countries involved. In this respect, a great deal was achieved in the period 1943-47, when it became possible, partly because of the special war-time conditions and facilities, to co-ordinate anti-locust measures in most of the invaded countries. The campaign costs were estimated at about £1 million per annum, but this expenditure was fully justified, since this was the first time in history that a plague of Desert Locust caused practically no losses of crops. A similar campaign, in which the experience of the past is being used to introduce improvements, is now in progress against the new plague of the same locust which commenced two years ago. Again, every effort is being made to induce all countries to adopt modern control methods and to link up the local plans, which is not easy in the present disturbed state of the world.

In other countries and continents it appears even more difficult to reach the necessary pooling of efforts and, as long as this is impossible, insecticidal control of locusts will remain a palliative, and a costly one at that.

Discovery of outbreak areas

Since recent investigations have shown that locust plagues arise from relatively restricted outbreak areas, it was natural to conclude that a discovery and delimitation of outbreak areas of each locust species should provide a definite hope of checking outbreaks in the initial stages. The discovery of outbreak areas of the Red and the African Migratory Locust has provided a basis for testing this theory. After necessarily protracted discussion, the groups of African countries respectively threatened by the two locusts have agreed to set up permanent organisations, internationally financed, whose first duty it is to keep a constant supervision of the outbreak areas and to suppress any concentrations or small swarms. The system proved to be workable and both organisations have already scored successes in suppressing local outbreaks which otherwise would have developed into plagues. Such suppressive control of locusts has one drawback—it must never be relaxed, and even a temporary slackening of scouting may lead to some concentrations escaping attention and getting out of control.

Ecology of outbreak areas

There is, however, a possibility, although still somewhat theoretical, of a more radical solution of the problem. Since the formation of initial swarms occurs only in special outbreak areas, these areas must possess some peculiar ecological conditions which favour gregarisation of solitary locusts. If these conditions were known, it might be possible to alter them in the direction of preventing phase transformation. There is little doubt that these conditions are not the same for different locusts, and research in each outbreak area is needed before the practical measures of outbreak prevention can be formulated. This type of research which must be continuous is an obvious long-range task of the same permanent organisations which are at present engaged

n outbreak suppression, but it requires a much greater development of their research activities.

The future

One might well ask whether the present plans for a rapid agricultural development of subtropical and tropical countries do not in themselves spell the doom of locusts, as many people believe. Unfortunately, this belief has no foundation in fact, and it was the firm opinion of the international conference of locust experts in Cairo in 1936 that the available evidence tends to show that locust activities are, on the whole favoured rather than hindered by man's activities. Deforestation, overgrazing, patchy cultivation in desert areas are all, in one way or the other, contributing to make the locust more difficult to control, while the extension of crop areas in regions liable to locust invasions tends to increase the economic risks. The locust problem as a whole will remain a problem for a long time to come, but it can be ultimately solved, if the requisite detailed knowledge about each locust species is available. This can only come as the result of much more research.

Photos : Anti Locust Research Centre.

FAO Conference on Locusts

It is of interest to record in connection with the foregoing article on locusts that under the auspices of FAO it is proposed to hold a conference in Rome, from October 22 to 25, to consider the current extraordinary plague of desert locusts and the measures necessary to combat the recurrent locust invasions which menace food production over large areas in Asia and Africa.

The agenda for the conference includes the following:—

(1) The Locust Situation and Outlook.
(2) Organisation of Control Operations and Plans.
(3) Co-ordination of National Anti-Locust Control Programme.
(4) Estimates by Countries of Equipment, Insecticides and National Contributions in 1952.

In a memorandum FAO points out that during the last two years unusually favourable conditions for locust infestation in Asia and the Near East have prevailed. Swarms of locusts have already occurred in India, Pakistan, Iran and Afghanistan, and the prospect is for greatly intensified activity. The food crops of millions of farmers are threatened and the situation, which is extremely dangerous, calls for international action on a scale commensurate with the scope and intensity of the invasion which is now taking place and which is predicted by experts to continue for possibly the next two or three years.

FAO is directly and intimately concerned with this problem because of the serious menace to food production and to the peoples of afflicted countries who may suffer untold hardship and possibly famine as a result of impending locust plagues. FAO is therefore anxious to do everything possible within its resources to avert the consequences of the locust infestation.

It may be mentioned that recent conferences on the control of the desert locust were held in New Delhi in November 1950 and in Cairo in March 1951, while the international meeting of the Desert Locust Survey was held at the headquarters of the Organisation at Nairobi, Kenya, on July 19-21, 1951. The latter meeting reviewed the current locust situation and the results of the co-ordinated anti-locust activities in the central region; future prospects and plans to combat the plague, progress of research, and budget estimates were also considered.

It was agreed at this meeting that the food and agriculture organisation of the United Nations was the appropriate agency through which regional and inter-regional co-ordination could be achieved and the hope was expressed that FAO would take such steps as may be necessary to this end. It is in accordance with the recommendation that the forthcoming conference has been organised.

Cotton Research in the British Commonwealth

The research work on cotton carried out under the Empire Cotton Growing Corporation during the season 1949-50 is reported in a volume* recently issued by the Corporation. The main points which have emerged are reviewed in a foreword to the volume written by Dr. J. B. Hutchinson, F.R.S., Director of the Corporation's Research Station at Namulonge in Uganda, and this we reproduce below.

IN the season under review, the Nyasaland station experienced disastrous floods, and the Lake Province of Tanganyika had a difficult time, largely owing to the aftermath of food shortages. Larger crops than usual were obtained in Eastern Tanganyika and Northern Nigeria. South Africa planted a larger acreage than usual, but pest attacks were heavy, and yield per acre consequently disappointing.

Crop husbandry

Problems of land use are most pressing in the West Indies, where large populations have to make a living on small islands, and interesting work on the reclamation and utilisation of steep hillslopes is in progress, along with experiments on the use of rotations allowing more intensive cropping of the land. Land use in Africa is bound up with the problem of the maintenance of soil condition under arable cultivation and the use of resting leys for soil improvement. In Tanganyika, data from Ukiriguru hill sands show substantial improvements in yield following resting treatments in a number of trials. In the first year after opening from tumbledown fallow, however, a depression was recorded, and this may be compared with the note from Samaru, in northern Nigeria, that land freshly broken from grass gave lower yields than old established arable.

Fertiliser trials are for the most part of local significance, and should be interpreted in terms of local soil conditions, but data on response to nitrogen are of general interest. The intimate relation between water supply and nitrogen status is shown by Queensland data, and responses to nitrogen in fertiliser trials elsewhere should be studied in terms of the effects of soil moisture on the accumulation of nitrate or its removal by leaching. The importance of timely planting is emphasised in several reports, and there can be no doubt that the interrelations of moisture supply and nitrogen status are among the dominant factors in determining optimum sowing date.

Much remains to be learnt of the moisture relations of the soil and their effect on the cotton crop. Intensive rain is a very im-

*Empire Cotton Growing Corporation. Progress reports from experimental stations, season 1949-50. London, 1951. Price 3s. 6d.

portant factor in soil erosion—in Queensland a rate of 0.40 in. per hour or more is regarded as erosive rain—and is largely wasted in run-off. The effect of such conservation methods as tie-ridging on soil moisture needs investigation in the light of data on rainfall intensity and the distribution and frequency of storms.

Mechanical cultivation is being developed in Tanganyika and Nyasaland, and mechanical picking in Queensland and Southern Rhodesia, where mechanical cultivation is already well established. In Nyasaland the difficulties of the change-over from the hoe to the tractor plough are considerable, and the importance is emphasised of adequate preparation of the land for mechanisation, by thorough clearing and stumping. Considerable advantages in terms of timely planting of the crop are anticipated from the mechanisation of land preparation in the Lake Province in Tanganyika. Mechanical picking is still in the experimental stage. In Queensland only 73% of the crop on very vegetative plants was taken by the picker, and in Southern Rhodesia the first experiments showed what elaborate organisation and equipment will be necessary to produce machine-picked lint in a marketable form.

Entomology

The reports record the entry of commercial firms into the field of cotton pest control in South Africa. All available evidence emphasises the need for the fullest understanding of the bionomics of pests and of associated insects before insecticidal control can be undertaken with good prospects of success. In Eastern Tanganyika, for instance, the use of insecticides in a trial was followed by a serious attack of aphis, believed to have resulted from the destruction of predators. In Northern Nigeria, hopes of an economic attack by insecticides on red bollworm depend upon confining the initial outbreak to a short period by plant sanitation methods. Similarly, the timing and intensity of American bollworm outbreaks depend on the timing of fruiting in alternative hosts, both cultivated and wild, and any insecticidal control on an economic scale would depend on a careful planning of the cropping system to minimise the outbreak and to confine it to a limited and predictable period.

Important data are available from Nigeria, Nyasaland and Tanganyika on red bollworm. Its bionomics in Nigeria have now been made clear, and an intelligent attack on the insect thus becomes possible. The failure of a non-cotton year to reduce red bollworm infestation in an experimental area in Nyasaland may be noted. A cotton-free zone five miles in radius was ineffective in reducing egg laying at the centre in the following season, and it was concluded that the flight range of the moth must exceed five miles. Red bollworm larvae collected from *Gossypioides kirkii* in Tanganyika yielded a moth which was classified as *Diparopsis* but probably not *castanea*.

Plant pathology

Verticillium wilt appears to be spreading in South Africa, and developments will be followed with interest in view of the possibility that this disease may become more serious in other parts of Africa.

Bacterial blight, or blackarm, has been recorded as important at many stations. Though the ultimate solution must be the breeding of resistant varieties, information on the pathogenicity and epidemiology of the disease is much to be desired, both as a prerequisite to the design of control measures, and as a guide to those engaged in breeding for resistance.

Plant breeding

The outstanding feature of the plant breeding sections of the reports is the interest in a wider range of material. In this respect, Barberton is the most advanced, with a derivative of a cross (A2106) already in general cultivation, and others following on. In the Sudan, 'BAR' stocks derived from gene transference work are in an advanced stage of multiplication, and would have been in greater bulk but for the need for caution in assessing the quality of all new material. In the West Indies, hybrid stocks have been brought to the quality level of the superfine V135, and have provided material for tests of better quality varieties to replace MSI in Antigua and Nevis. In the Lake Province of Tanganyika, a degree of blackarm resistance is needed beyond that to be found in East African stocks, and hybrids are to be made with 'Albar,' which is the name given to highly resistant lines selected at Shambat and Namulonge out of Nigerian Allen.

From the Sudan, good progress is reported in transferring jassid resistance to Sudan Egyptians. In the longer range genetic work in progress there, the acquisition of almost all the remaining wild species of the genus *Gossypium* may be noted, and also the successful synthesis of an allopolyploid from *G. arboreum* × *G. raimondii*, the putative parents of the New World cottons.

Seed multiplication and distribution are discussed in the Tanganyika and Nigerian reports. In Tanganyika UK46 now covers nearly the whole of the Lake Province, and is being followed by UK48. The wisdom of putting out a mixture of several good strains, and following it with a better mixture as one becomes available, has been amply demonstrated. The method has the advantages of an early realisation of the improvements available in the breeding plots, flexibility, and ease of replacement by something better without disturbing the market. In Nigeria attention has been paid to the problem of getting the improved strain, 26C, out over the whole of the area as soon as possible. It is now estimated that in future complete replacement can be achieved in seven years.

Quality problems

The success of early sowing and wide spacing in improving grade in the Sudan Gezira is important, and has been made possible by the breeding of cottons sufficiently resistant to blackarm to be planted in the period when climatic conditions favour the spread of the disease. The demonstration in Antigua that for good grade, seed cotton should be picked as soon as possible and should not be tightly packed, is of general importance for rain-fed areas.

Conclusion

An analysis of these reports by subjects tends to obscure the unity of any study of the growth and productivity of a crop plant. The cotton specialist is of necessity involved in problems belonging to several scientific disciplines, and it is a feature of these reports that it is not possible to draw distinctions between crop husbandry, pest and disease studies, and plant breeding without losing some of the essential merit of the work recorded.

Mr. S. W. Cheveley

Mr. S. W. Cheveley, managing director of Plant Protection Ltd. since 1944, has been appointed chairman of the Central Agricultural Control of Imperial Chemical Industries Ltd., with effect from January 1, 1952, when Mr. F. C. O. Speyer, C.B.E., the present Central Agricultural Control chairman, retires.

Mr. Cheveley was born in Yorkshire in 1900 and his early farming experience was in the East Riding, Cumberland and South Wales.

He was associated with Sir Frederick Keeble in the formation of Jealott's Hill Research Station, and played a major part in the development of grass drying under Dr. R. E. Slade. He wrote the first book on that subject. During the last great war Mr. Cheveley helped in food production campaigns under the direction of the Ministry of Agriculture and was awarded the O.B.E. for services to agriculture.

Australia's Rabbits Controlled by Virus

T. A. G. HUNGERFORD

IN Australia, rabbits annually cause incalculable losses in grazing and, by denuding hundreds of thousands of acres of grasslands, accelerate soil erosion.

So far, methods for their control have proved merely palliative, but recently a virus disease called myxomatosis gives some indication that some measure of success may be in sight.

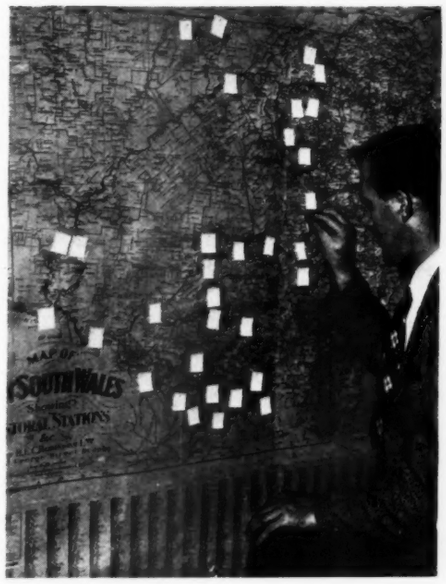
Myxomatosis appeared in South America towards the end of the last century, when it was observed to infect hutches of domestic rabbits. From the fact that the gauzing of hutches reduced the prevalence of the disease, it was recognised as mosquito-carried, and became known as the 'mosquito disease.' Until introduced elsewhere for experimental purposes, it was unknown outside America.

Between 1934 and 1936 exhaustive experiments sponsored by the Commonwealth Scientific and Industrial Research Organisation, were carried out in England, on confined and wild rabbits. The work was then transferred to Australia and continued by the Division of Animal Health and Nutrition in Victoria; this carried on until 1943, when, owing to the war and the discouraging results obtained, it was discontinued.

In 1949 the Wild Life Section of the SCIRO, at Canberra, began to plan a further attack on the problem in view of the fact that it was known that myxomatosis is an exceptionally virulent disease, transmitted with difficulty by contact, that there is little likelihood of rabbits developing immunity to it, that its use as an agent for rabbit control would not involve risk to man or livestock, and that it is carried by mosquitoes, stick-fast fleas and probably by any blood-sucking insect.

The year of 1949 was devoted to planning a campaign designed to exploit the findings of previous research which had evolved the method of infecting healthy rabbits by introducing virus discharges from diseased rabbits under the eyelids and rubbing it into freshly scarified patches of skin. To attempt to establish the disease in colonies of wild rabbits, the technique was adopted of freezing and mincing the livers and lungs of infected rabbits: by using a modification of the ordinary spring-trap that leaves the animal otherwise unharmed, they succeeded in causing infected punctures in the skin of the animal setting it off.

The field campaign started in 1950, and nearly 200 warrens were infected in different parts of the State. The same result



As reports come in from country areas detailing the spread of the introduced virus disease of rabbits, myxomatosis, the areas of infection are marked on a map in the Canberra office of the Commonwealth Scientific and Industrial Research Organisation

was obtained—a mild epidemic in the warrens infected, but no indication that the effects would spread further afield.

In September 1950 a field team infected four properties, at Balldale, Coreen, Rutherglen and Wymah. They stayed to observe the results of all these infections, which followed the accepted pattern, and then returned to Canberra.

However, in December, a farmer, Mr. Fred Taylor, whose property was one of those originally infected, reported that he noticed numbers of sick and dead rabbits in the vicinity. The symptoms of the disease as he described it tallied with those of myxomatosis.

This marked the beginning of what has been described by Sir Frank Macfarlane Burnet, Director of the Walker and Eliza Hall Research Institute, Melbourne, as the only recorded instance in which a deliberately planted disease has spread amongst wild animals.

After the first tenative reports the matter became one of national importance; it was found that the infection was being carried by mosquitoes in the vicinity of swamps and river frontages and lagoons over an area of 100,000 square miles in New South Wales, and it is also stated that Dr. Clunies Ross, chairman of the CSIRO, anticipates it will spread throughout the tributaries of the Murray River.

It has already spread into Victoria and the most recent information is that rabbits dying from myxomatosis have been reported from Mannum, Swan Reach, Waikerie and Springton in South Australia. Although the dry country between South Australia and Western Australia would probably prevent mosquitoes from carrying the disease that far, CSIRO suggests the liberation of diseased rabbits in that State.

It is too early to hail myxomatosis as the answer to rabbit infestation of grazing lands. The present spread was accelerated by the widespread floods of recent months which favour the breeding of mosquitoes, while unusual winds have distributed the insects further and more widely than they would normally have travelled.

The disease can spread only in the summer, when mosquitoes abound; it will not spread throughout dry areas, and it is not yet known whether it will survive the winter so that the spring emergence of mosquitoes can begin to spread again.

The fact remains that myxomatosis provides a weapon for use on certain types of river frontage country where hitherto the problem of rabbit control has proved almost insuperable.

Photo : Australian News and Information Bureau.

Award of the R. B. Bennett Empire Prize, 1951

Her Royal Highness The Princess Elizabeth, President of the Royal Society of Arts, on the unanimous recommendation of the Council of the Society, has been graciously pleased to award the R. B. Bennett Empire Prize for 1951 to Mr. E. Bruce Levy, O.B.E., Director of the New Zealand Department of Scientific and Industrial Research, for his important work on grassland farming.

In 1944 the late Lord Bennett endowed the R. B. Bennett Empire Prize of 100 guineas, to be awarded every third year by the President of the Royal Society of Arts for the most outstanding contribution from the Dominions, India and the Colonies to the promotion of the Arts, Agriculture, Industries and Commerce of the Overseas Empire.

The first award was made in 1945 to Dr. Charles Camsell, C.M.G., Canadian Deputy Minister for Mines. The second was in 1948 to Sir Frank Stockdale, G.C.M.G., C.B.E. (since deceased).

Experimental Agriculture

Part I

Dr. E. M. CROWTHER

President of Agriculture Section, British Association, 1951

We reproduce below a shortened version of Dr. E. Crowther's presidential address to the Agriculture Section of the British Association at the meeting in Edinburgh last August, in which he reviewed the development of experimental agriculture in the past 100 years. Experimental methods have changed and evolved strikingly and by the application of statistical analysis to the planning of experiments and interpretation of results it is now possible to achieve a higher degree of accuracy than was formerly the case. In his paper Dr. Crowther discusses the possibilities and indicates the limitations in this regard.

I PROPOSE to review some of the main steps in the development of experimental agriculture during the last 100 years.

The middle of the 19th century forms a convenient starting point, because at that time farming in this country was passing from the subsistence to the commercial pattern to feed the rapidly growing urban populations.

In Edinburgh it is fitting to recall that the first critical review of field experimentation grew out of work initiated in 1842 by a group of Midlothian farmers. The object of the association includes the following statement: ' The design of the association being the improvement of agriculture by the application of chemistry, vegetable physiology and geology, it contemplates as its leading objects—

' 1. The diffusion of existing information . . .

' 2. The enlargement of our present knowledge, by experimental investigations of practical agriculturists in the field, and the chemist in the laboratory . . . '

Professor James F. W. Johnston, of Durham, was appointed chemist in July 1843. His investigations and writings did much to influence the development of agricultural science in this country and abroad. One of his American students, J. P. Norton, became the first professor of scientific agriculture. His successor, S. W. Johnston, has recorded that the Connecticut Agricultural Experiment Station, founded in 1877, ' was the first permanent organisation of the kind in America and has largely grown out of the influence of Professor Norton.'

Analysis of soil problems

Some practical men and administrators may imagine that the principles of soil fertility can be derived deductively from the pure sciences. Many will prefer to proceed through generalisations built up from carefully ascertained facts—through what Johnston called ' inductive experimental agriculture.' The contrast between the deductive and the inductive approaches to soil fertility problems can be illustrated from the writings of the main protagonists of the two schools a century ago. In 1843 Liebig wrote: 'Now that the conditions which render the soil productive and capable of affording support to plants are ascertained, it cannot well be denied that from chemistry alone all further progress in agriculture is to be expected.' Lawes replied in 1847 that ' Agriculture will eventually derive important assistance from chemistry, but before it can propose any changes in the established routine of the farmer, it must, by laborious and costly experiments, explain this routine in a satisfactory manner.' Again, in 1851, Lawes and Gilbert wrote: ' If we would attain by the aid of science a rational system of agriculture, the actual facts of the art itself, as well as the indications of direct experiments in the field and the study of the functional actions of plants and animals, must receive a due share of attention. Chemistry alone will do nothing for practical agriculture.'

Some problems may fall into better perspective if we recall that the basic discoveries in agricultural practice were made in prehistoric times. Primitive cultivators in Africa and Asia know that land needs to be rested after spells under tillage. The pattern of alternating cultivation and resting can be traced through history from shifting cultivation, through the wild grass-wheat rotation, the mediaeval three-field system and the Norfolk four-course rotation to the Scottish system of long leys. The details have changed but the basic rhythm remains.

The nutrient elements

The early natural philosophers grew plants experimentally to analyse air and water, but there could be no real progress until the basic principles of chemistry and plant physiology had been established. Early in the 19th century Sir Humphry Davy and many others accepted the traditional view that plants feed on humus. The demonstration by Senebier and de Saussure, that plants can obtain most of their carbon from the atmosphere was profoundly disturbing to the experts of the time. Liebig's great service was to stimulate discussion by expounding the new interpretation and ridiculing the old, but his writings provide many examples of the danger of approaching agricultural questions through chemical theorising unchecked by field trials.

The foundations of soil science were laid by Boussingault in France and Lawes and Gilbert in England, who concentrated on establishing the facts by experiments in field plots and pots with chemical analyses on the soils, manures and crops.

Liebig, on the other hand, was convinced that it was impossible to make significant quantities of ammonium salts and that in any event they were unnecessary. Even in 1863 he wrote: ' Though manufacturers of manures add a certain amount of ammonia to their productions, this is chiefly to humour the fancy of farmers for this substance. . . . This prejudice will soon disappear of itself when farmers have learnt to make a proper use of the nitrogenous food which nature supplies spontaneously.'

For nearly 50 years the most difficult theoretical problem was to explain the

beneficial effects of legumes on following cereal crops. Boussingault had found that clover could obtain nitrogen from the air, but Lawes, Gilbert and Pugh failed to confirm this. In 1880 Hellriegel and Wilfarth made the observation that in an irregular pot experiment the good clover plants had root nodules, subsequently shown to contain micro-organisms capable of absorbing atmospheric nitrogen, and passing it to the host plant.

This brief summary serves to focus attention on two points of the greatest practical importance. The potential use of nitrogen fertilisers is limited by progress in chemical technology and the skill of agriculturists in using nitrogen fixed by micro-organisms or in factories. On the grasslands of Britain and the prairies of North America and in much of the tropics, a proper choice between legumes and fertilisers can be made only after prolonged trials in the field.

The value of bones had long been known but the results were erratic and uncertain. By introducing superphosphate made from sulphuric acid and bones or phosphate rock, Lawes provided a more active and reliable material. Over many decades world consumption of phosphates, mainly as superphosphate, continued to increase at roughly 7% per annum. There are good grounds for expecting continued progress at a similar rate, for there are abundant reserves of phosphate rock and almost negligible quantities of fertilisers have been used on the inherently poor soils of most of Africa, Asia and South America.

Lawes and Gilbert found from their field experiments that chemical analyses did not reveal the nutrient requirements of different crops. The practical value of potassium salts was not established until the 1880's when commercial supplies became available from the German mines.

The attitude of farmers and agricultural chemists to calcium and magnesium limestones illustrates the danger of relying on a few experiments at isolated centres. The use of burnt lime or chalk was traditional in Britain; the practice fell into decay in the latter half of the century as further results were obtained from fertilisers. Lawes and Gilbert paid little attention to liming because most of their Rothamsted fields contained large residues of calcium carbonate from earlier chalkings. This had to wait until 1876 when the Duke of Bedford and the Royal Agricultural Society set up the Woburn Experiment Station. Within 20 years continuous barley crops failed disastrously on plots receiving ammonium sulphate. It was found that the soils had become acid to litmus paper and that good crops could be grown again after liming. These results renewed practical interest in liming and stimulated chemists into devising a variety of tests for soil acidity and lime requirements.

There had also been a prejudice against the use of magnesium or dolomite-limestone. The prejudice may have survived from some very early experiments in which heavy dressings of burnt magnesium lime proved too caustic.

Sodium, too, had a chequered history. Some of the striking effects of sodium salts on sugar beet and mangolds were ascribed to the liberation of available potassium in the soil. During the last ten years or so some 200 experiments on sugar beet have shown that sodium greatly increases yields. The sodium is absorbed in large quantities, but there is no increase in the amount of potassium taken up by the crop.

Trace elements

It has been known for many years that several other elements are essential for plant growth in water or sand, but for a long time it appeared that most soils supplied them in sufficient quantities. Systematic search has led to the discovery of conditions in which crops can be cured of chlorosis and other symptoms by supplying small amounts of appropriate salts. There were many striking examples of deficiencies of manganese and other elements in the United Kingdom during the war. Deficiencies are often found in fruit trees and vegetables. Sometimes livestock suffer from a deficiency of cobalt, though the herbage may appear normal. In parts of Australia good pastures have been established for the first time by supplying salts of copper, zinc or molybdenum, the latter at rates of only a few ounces per acre.

The question has often been asked whether small amounts of these ' micronutrients ' or ' trace-elements ' should be included in ordinary fertilisers to cover the risk of unrecognised deficiencies. At present it seems wiser to await definite evidence of the need, because excesses are always wasteful and may even be dangerous.

Early field experiments

In his book *Experimental Agriculture*, published in 1849, James F. W. Johnston was forced to the conclusion that ' scarcely any of the results we have as yet obtained are to be relied upon as secure grounds for scientific opinion; yet they may be considered to have cleared the path to surer results by pointing out sources of error previously unknown.'

Johnston realised that no statement of comparative yields was of any value unless it was accompanied by some indication of the variation between similarly treated plots in the experimental area. He raised, but could not answer the question how far discrepancies between yields on similarly treated plots affect the degree of confidence to be attached to differences between mean yields for contrasted treatments.

It is not easy to understand why the warnings and advice of Johnston had so little influence on the subsequent development of agricultural experimentation. Johnston may have advanced too bewildering a variety of unrelated proposals. Farmers may have been discouraged by the contradictory results on different soils. At that time chemists appeared to expect all soils to respond in much the same way to various kinds of fertiliser. Thus, in 1880, when T. Jamieson in Aberdeenshire reported almost as good results on turnips with finely ground mineral phosphates as with superphosphate, A. Voelcker in England replied by ' directing attention to a few published experiments which are diametrically opposed in their results to those which Mr. Jamieson obtained.' It was not until 50 years later that both kinds of results were obtained in the same investigation with the important addition that it was possible to relate the observed differences to properties of the soils tested. Ground mineral phosphate often gives good results on very acid soils, but not on slightly acid or neutral soils.

Modern field experiments

Rothamsted was still laying out single-plot experiments in the early 1920's, but it atoned for its shortcomings by stimulating R. A. Fisher into devising new experimental methods in the light of his mathematical researches. He solved Johnston's problem of estimating the reliability of observed treatment-differences.

In well-conducted field experiments ten replicates are generally required to establish yield differences of the order of 5 to 10%. This means that many plots will be needed to test whether a given nutrient improves yields and quite elaborate experiments will be required to decide the best form, rate and manner of applying it.

Many ingenious methods have been devised by R. A. Fisher and F. Yates to extend the range of questions which can be studied in field experiments with between, say, 25 and 75 plots. Johnston's method was developed to provide the ' Factorial Experiment,' one of the most useful patterns now available.

In a factorial experiment testing three materials, say nitrogen, phosphorus and

potassium fertilisers, every plot is used to measure the effect of each material. It happens very often that such an experiment is as accurate and informative as three experiments, each on the same scale testing the separate elements. In addition, the factorial experiment will show how far one treatment affects the behaviour of another.

Sometimes such so-called 'interactions' supply useful information about the way various treatments act. Sometimes they point to favourable combinations of treatments. An important early example was an experiment by F. G. Gregory, F. Crowther and A. R. Lambert in 1929-30 on irrigated cotton in the Sudan Gezira. The earliest sowings gave the biggest response to nitrogen fertiliser; the second sowings gave the best average yields; the third sowings could be improved only by close spacing. Extra water improved yields only where cotton was sown early and manured. These findings played a large part in the notable success of the Gezira Irrigation Scheme.

In many parts of the world one of the best approaches would be to test all combinations of nitrogen, phosphorus, potassium fertilisers and two other factors, *e.g.* farmyard manure and limestone. This can be done conveniently on 32 plots, set out in four blocks.

The most profitable dressings can often be assessed sufficiently well by experiments with three rates of application, *e.g.* 0, 1, 2, preferably testing two or three nutrient elements in a single experiment. Field experiments are rarely precise enough to determine the exact relationship between yields and rates of treatment, but simple expressions for the law of diminishing returns can be used for calculating responses for other rates near those actually tested. It may, however, be dangerous to extrapolate far beyond the experimental range using arbitrary constants.

Wherever possible, experiments should be conducted at several centres and in several seasons to build up representative averages. The need for large short-term experiments must be conducted on ordinary commercial farms, for there can never be enough experimental farms to provide sufficient variety of soil conditions. Experimental farms should confine their work to long-term experiments requiring security of tenure and to short-term experiments too complicated or too detailed to be carried out at a distance. The experimental farm must also hold some of their most uniform fields at low nutrient levels if, later on, they are to be suitable for soil fertility experiments. This is difficult to reconcile with the desire of farm managers and committees to show bumper crops and favourable balance sheets. There is a strong case for discriminating sharply between demonstration farms and experimental farms.

All possible methods should be used to characterise the soil and the agricultural conditions in each experiment so that the results may be classified into well-defined groups or related to soil data by regression analyses.

For over a century farmers and chemists have hoped that the principal factors in soil fertility could be determined by soil analysis. Since 1845 it has been known that a distinction must be made between 'the dormant and the active ingredients of a soil.' A good deal of confusion is still caused by the custom of expressing the results of soil analyses as 'available plant foods.' There are no sharp distinctions between the various kinds of phosphorus and potassium compounds in soils, and there is no reason to assume that any analytical separation will pick out the forms plants use. The methods of soil analysis used in advisory work are empirical but some have proved very useful. It is one of the main functions of liming and manuring experiments to provide data for calibrating and improving these methods.

There is no need to postpone field trials until the soils of the region have been mapped, for, if a uniform site is chosen and its position recorded by grid-reference, the results may be of service to soil surveyors in the practical application of their work. One of the main difficulties in the soil survey of the United States is to obtain sufficient reliable field data for individual soil series for making productivity ratings, economic analyses and advisory recommendations.

(*To be concluded next month*)

Plough More — Feed More

The Minister of Agriculture Exhorts British Farmers

Speaking at the Corn Exchange in Leicester recently, Mr. Tom Williams, Minister of Agriculture, reviewed the achievements of British farmers during the last four years and introduced a new slogan for the future—'Plough more—feed more.'

Since 1947-48, he said, milk production had increased by no less than 300,000,000 gal., or 30% higher than before the war. Similarly, beef and veal production had increased by 120,000 tons; mutton and lamb had gone up by one-third; pig meat was well over two and a half times the 1947-48 figure; and egg production was nearly a third above pre-war level. Silage production had increased sixfold since 1947 and dried grass nearly four times.

Turning to Government aid given to the industry in carrying out the expansion programme, Mr. Williams mentioned the restoration of open-cast coal sites which has now improved, mainly with the help of the Mineral Workings Act. Each year £3,500,000 worth of capital works has been carried out on arterial water courses with Government aid and £5,000,000 has been spent over the past six years on grants for ditching and drainage; 33,000 farm water supply schemes have been approved for Government grants.

Between 1948 and 1950 the number of tractors on farms had increased by a quarter, combine harvesters had doubled, pick-up balers trebled and milking machines increased by a half.

The Minister paid tribute to the valuable services of the County Agricultural Executive Committees and also the much maligned civil service. The County Committees, he said, at present employ 7,000 people, all of whom were necessary for such things as the animal feeding stuffs schemes, organisation of committee labour and machinery, water and drainage supplies, subsidy claims on hill sheep, etc.

Referring to the switch from milk to beef, he mentioned that the 1952 milk target had been passed a year ago and so some increase in the incentive to beef production had obviously been needed.

The purchase of feeding stuffs from the world market would continue so far as world supplies and our financial position allowed, but the need for increasing home production of feeding stuffs was growing greater every year as fast as the animal population rose. There was some concern over the decline in tillage during the last 12 months; much of this was due to bad weather and it was hoped that this decline would be wiped out. The recent increase of prices of imported feeding stuffs would provide a spur to farmers to plough more.

Concluding, the Minister said: 'The Agriculture Act of 1947 gives sure markets and fair incomes. I ask you, therefore, despite the problems of weather, shortages and increased costs, to go on producing more. To do this we need to retrieve the tillage which the weather robbed from us this year and to get the best not only out of every acre under the plough but out of every acre under grass as well. In particular, I ask for more meat, whilst you hold the line on milk and eggs. I ask you, in fact, to plough more and feed more.'

NEW BOOKS

TWO PRODUCTIVITY TEAM REPORTS

Productivity in Farming

Productivity Team Report. Pp. 43. Illustrated. Anglo-American Council on Productivity. London, 1951. 2s. 6d.

Last year a farming productivity team visited America under the Technical Assistance Programme of ECA and the auspices of the Anglo-American Council on Productivity.

The team included representatives of the National Farmers' Union, the Union of Agricultural Workers and the National Agricultural Advisory Service; also an agricultural economist. This group was sent to the United States to study the management of agricultural labour and machinery and to recommend measures likely to increase the productivity of labour in the U.K.

As productivity was the watchword an itinerary was arranged which took the team to the more highly developed farming areas of Maryland, Ohio, Missouri, Nebraska, Michigan, New York, Pennsylvania and New Jersey. All these States are situated in the north-central and north-eastern parts of the U.S.A.

The report includes the team's observations on many aspects of labour productivity, farm practices and methods, the development of machinery, agricultural education and a summary and recommendations. Labour as a factor of production seemed on many farms to take precedence over land and capital and the team was impressed by the American farmers' efforts to save labour through planning and the adoption of labour-saving techniques. For example, fewer kinds of crops are grown in order that there might be sufficient of each to justify the use of specialised machines. The complexity of mixed farming is not so evident as in Britain.

Co-operation between farmers is fairly common; for instance, three farmers might own respectively a combine harvester, a sugar-beet harvester and a potato harvester, each being responsible for the upkeep and operation of his own machine on all three farms. This kind of neighbourly agreement appears to work very well.

The value of maize, whether grown as a cereal or for fodder, in promoting high labour productivity was pointed out, and the team suggested that the development of substitutes such as arable silage crops for fodder roots might prove to be greatly labour-saving for British farmers.

The team states that the American farmer tends to think more in terms of costs and returns than his British counterpart. To the former good crop husbandry often means good net returns, while to the latter it means a good tilth and seed bed, frequently obtained, however, at a considerable cost in man and machine labour. For instance, the hours of manual labour per acre of wheat in Britain are about 33 when harvested by a binder, or about 12 when harvested by a combine; comparable figures in Ohio, Michigan and New York States are about 11 by binder and about half that figure when combined.

Discussing machinery, the report says that in the U.S. it is fully realised that not only the machine but the farm as well is capable of modification. The advent of electricity since the setting up of the Rural Electrification Administration of the U.S.D.A. in 1935 has increased the proportion of farms with electricity from 10% to over 85%; no more than 40% of British farms have electricity.

The team's recommendations included greater attention to farm planning, the encouragement of farmers' neighbourly co-operation, the increase in the volume of production *or* decrease in the amount of labour employed, and closer collaboration between farmers, manufacturers of and dealers in agricultural machinery.

The 43 pages are filled with interesting sidelights on modern American farming and will no doubt prove profitable reading to progressive farmers at home and also in comparable climates overseas.

The Hop Industry

Productivity Team Report. Pp. 113. Illustrated. Anglo-American Council on Productivity. London, 1951. 9s. 6d.

The second agricultural productivity team to visit America last year studied the efficiency of American hop production methods at each stage from growing to marketing and made recommendations likely to help the efficiency of the English hop industry. This team consisted of four hop growers and an agricultural economist.

Their route was on the west side of the American continent where all the important hop-growing areas are situated and the team travelled up from California to British Columbia during the growing season and then returned to follow the same route again for the study of picking operations.

It is interesting to note that the idea of sending a team representative of the English hop industry to America arose out of the fact that during 1948-49 American hops were offered for sale in the U.K. and European markets at prices below the average cost of producing English hops. The development of mechanical harvesting in America was thought to be one of the main reasons for the relative cheapness and the team therefore paid particular attention to this aspect of their production.

As a result, the English hop industry was recommended to consider fully problems of machine-picking with emphasis on the development of such machines to be adapted to English conditions. The wholesale adoption of American methods would not solve the problems of costs or labour supplies which at present face the industry.

The team found that the standard of husbandry in England is generally superior to the average in America, the average yield at home being higher than in all but one district in America. Cultivation, irrigation, manurial treatment and in fact the whole practice of growing hops in America have been developed and adopted to the production of hops suitable for machine picking. Also climate and management facilitate machine picking and all these deficiencies account for the relatively much greater success of the mechanical method in the U.S.A. than in England.

As with the Eastern farms, the layout of the Pacific coast hop-yards is extremely favourable to the economical use of labour which is now 24% more costly than in England. At present, with the problem of higher production, it is difficult to decide how far it would be profitable to grow hops essentially for machine picking under conditions in this country and each grower must consider his own possibilities and decide for his own conditions whether increased mechanisation would be profitable.

The report is extremely comprehensive and includes detailed descriptions of all aspects of hop-growing, picking, drying, baling and marketing. There are 11 appendices on detailed subjects, such as the various picking-machines, American hop-growing soils and yields, and acreages of hops in various countries. There seems little doubt that this report will be read as a 'must' by a large section of the hop industry in this country.

East African Timbers

Timber Information Leaflet No. 28, 1951. Timber Development Association Ltd., London.

A revised and enlarged edition of this Timber Information Leaflet has now been published and includes 15 new species

and is furnished with a new index of botanical and common names.

Now that a number of East African woods are being exported to various parts of the world this up-to-date leaflet will be valuable to timber importers everywhere. It describes the principal commercial timbers of East Africa, *i.e.* Kenya, Rhodesia, Tanganyika, Uganda, Nyasaland and Mozambique. Some 49 hard and soft woods are listed and described by their weights, colours and utility, besides their Latin and alternative names being given.

Agricultural Marketing

By G. R. H. Nugent. Pp. 55. Conservative Political Centre, London, 1951. 9d.

This booklet is one of the discussion series specially designed to meet the needs of the general reader as well as those taking part in discussion group work. Previous titles in the series have been 'Employment,' 'Pattern of Peace' and 'British Trade.'

Mr. Nugent has given a short history of the marketing schemes which have been tried in the U.K. during the past 30 or so years by the various governments in power. He then outlines some projected schemes, such as the apple and pear marketing scheme, sponsored by the N.F.U., and the pea marketing scheme.

The importance of developing producer marketing schemes is stressed, the conclusion being that improvement can best be achieved by encouraging growers to develop their own marketing arrangements, with suitable safeguards. The wartime system of control by the Ministry of Food is considered undesirable as a permanent arrangement.

WORLD CROPS

OUR NEXT ISSUE will contain three articles on aircraft: **the application of aircraft to agriculture** by P. H. Southwell, **measuring efficiency of top-dressing by light aircraft** by P. B. Lynch and **aerial surveying.** Besides these there will be items of interest on other aspects of aviation applied to farming—a subject which is receiving increasing attention from agriculturists throughout the world.

An article on **collective farming in Jugoslavia** has been prepared by Dr. C. de Fellner, who has recently returned from that country, and this will also appear in the December issue.

Besides those already mentioned there will be other articles, regular features and the annual index for vol. 3.

Our Second Anniversary

'WORLD CROPS' BIRTHDAY LUNCHEON

OVER 60 guests met in London recently at a luncheon held in the Savoy Hotel to mark the second anniversary of the publication of WORLD CROPS: our first issue appeared in September 1949. Distinguished agriculturists from home and abroad, contributors and advertisers, had the opportunity of meeting together and exchanging news and views in a congenial atmosphere.

The guest of honour was **Sir John Russell,** F.R.S., formerly Director of Rothamsted Experiment Station and known the world over for his work on soils and manures. Speaking after the lunch, he stressed the importance of the Journal in disseminating information on agricultural progress, particularly as it is so important today that food production should be increased in all corners of the world. He mentioned the dependence of the U.K. on overseas crop production for many of her staple requirements—oilseeds, fibres, rubber, tea, coffee, cocoa, wine, much of her sugar and wheat, and many others.

A setback in almost any country would be likely to affect Britain. For instance, the political troubles in Indonesia had sent the price of pepper soaring, and obscure plant diseases in Zanzibar and the Gold Coast have affected our supply of cloves and chocolate. The importance of overseas production was not confined to the U.K. World peace now depended very much on Asia where half the world's population live—mostly hungry. The raising of the level of food production in Asia would be an all-important factor in maintaining peace, and the knowledge of how to do this was being steadily spread.

Sir John ended by wishing success in the future to the Journal.

Sir Harold Tempany, C.M.G., Editor, welcomed the guests and gave a brief history of the Journal, its inception and early stages. He credited the conception to W. Leonard Hill, whose enterprise and vision had made the publication possible. Sir Harold had accepted the Editor's chair after 44 years in the Colonial Agricultural Service and considered that the initial standard of the Journal had been maintained, judging by the amount of countries having subscribers, now numbering over 80. He paid thanks to the support received from contributors and official bodies, and also from advertisers.

Mr. W. Leonard Hill, Chairman of Leonard Hill Ltd., also spoke, mentioning the sister journals of WORLD CROPS and how they had started. The Leonard Hill Technical Group catered for the field of industrial science and chemistry and its journals covered many aspects, from the production of crops, manufacture of food, industrial chemistry, the fibre industry, paints, petroleum, right through to the new science of atomics.

The list of guests present included Sir William Ogg, Director of the Rothamsted Experiment Station, Sir John Simonsen, Director of Colonial Products Research, Prof. G. E. Blackman, Head of the Department of Agriculture, Oxford University, Prof. T. Wallace, Director of Long Ashton Research Station, Prof. R. Rae of the NAAS, Col. J. A. Robertson, Agricultural Counsellor for Canada, Dr. E. Marsden from the Office of the High Commissioner for New Zealand, Dr. G. R. Bates of the Central African Scientific Liaison Office, Mr. J. C. May, Director of the Empire Cotton Growing Corporation, Dr. G. Watts Padwick of Imperial Chemical Industries, and Dr. F. R. Petherbridge, entomologist to the R.A.S.E.

Also among the guests were several contributors whose names will be familiar to readers: A. C. Barnes, D. P. Hopkins, D. H. Grist, Dr. C. de Fellner, W. A. M. Walker, E. J. Hewitt, to name a few.

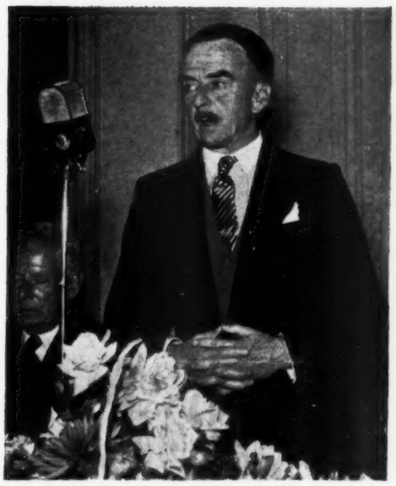
A display, illustrating the editorial coverage and circulation of WORLD CROPS, was shown in the foyer of the luncheon room and aroused considerable interest.

Our Contemporaries

A selection of articles appearing in the November issues of some of our sister journals in the Leonard Hill Technical Group is given below:—

- **'Food Manufacture.'** Symposium on Refrigeration and Ancillary Equipment.
- **'Manufacturing Chemist.'** Progress Reports on Economic Poisons.
- **'Muckshifter and Public Works Digest.'** 'Plant on Hire' by P. H. Saunders.
- **'International Chemical Engineering.'** 'The Use of Fluorescent Tracer Agents.'
- **'Petroleum.'** Abstracts from the Third World Petroleum Congress.

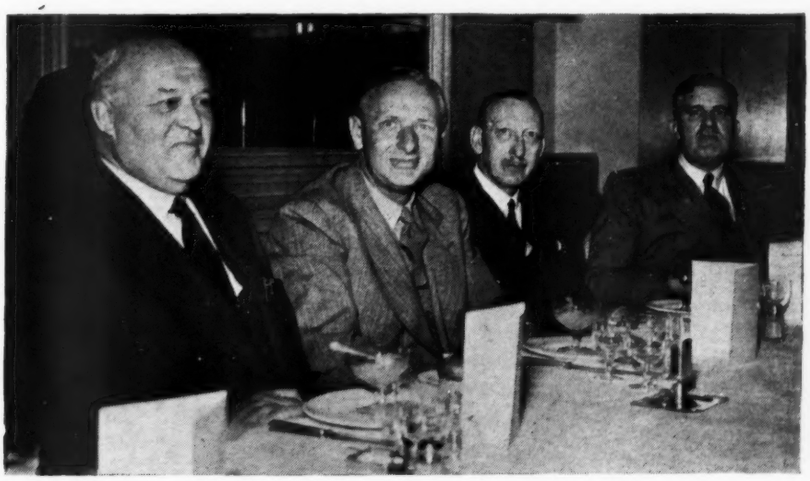
(Above) Sir Harold Tempany, editor of 'World Crops,' speaking at the luncheon



(Above) Mr. W. Leonard Hill, chairman of Leonard Hill Ltd.

(Above) Sir John Russell, F.R.S., guest of honour, spoke at the anniversary luncheon

(Below) *Left to right:* Mr. A. Berk, Prof. G. E. Blackman, Mr. J. C. May, and Mr. A. R. N. Roberts



(Below) (*Left*) Sir William Ogg takes a look at the 'World Crops' display (*Right*) *Left to right:* Prof. G. E. Blackman, Prof. T. Wallace, Sir William Ogg, Dr. F. R. Petherbridge and Prof. R. Rae

RESEARCH DEVELOPMENTS

Insect Control by Micro-Organisms

ENTOMOLOGICAL opinion has rarely been more sharply divided than it is now over the use of persistent contact insecticides. Some field entomologists believe that biological control of pests cannot be relied on to meet the needs of intensive cultivation, and cite the many instances of increased crop yields following the use of modern insecticides. By contrast, entomologists of the opposite view hold that chemical control frequently does more harm than good. They classify as adequate crop protectants many predatory and parasitic insects, as well as the 'microbes' which are pathogenic to insect pests.

These 'microbes' comprise unicellular animals, fungi, bacteria and viruses and as a group they have considerable economic importance, for not only are many insect pests susceptible to disease, but silkworms and bees may be decimated by uncontrolled epidemics.

Insect control by means of pathogenic organisms has been practised with indifferent results for a long time. In the last few years, however, there have been several instances in which the method has been most successful, as a result in large part of better understanding of the biology of the agencies concerned. In a recent monograph entitled 'Insect Microbiology' Steinhaus has very fully reviewed the relations between insects and their microbial parasites. The same author with G. C. Thompson has more recently concluded that natural epidemics cannot be relied to occur and, if they do occur, they frequently arrive too late to save the crop from serious damage.

Factors affecting spread of disease

The spread of disease among insects is favoured by warm humid conditions and by high population densities; very frequently they spread most quickly when the pests' food supply is running short. Even when an insect pest is present in relatively small numbers, it has been possible to initiate epidemics of disease by artificial means, provided environmental conditions are suitable. Thus for *Borrelina*, a virus which attacks the larvae but not the adults of the Alfalfa butterfly *Colias*, high humidities favour the spread of the disease because the larvae are more active in moist than in dry air. Similarly within normal temperature ranges a high temperature shortens the incubation period of the disease but leaves unaffected the rate of infection.

Work in California

Work in the San Joaquin Valley of California has recently proved that aircraft spraying can successfully be used to distribute virus infections and good control of *Colias* by *Borrelina* was obtained with a spray rate of only five gallons of virus suspension per acre. This suspension is cheap and easy to prepare, safe to handle, can easily be diluted in the field and leaves no hazardous residue on the fodder crop. The suspension which contained five million 'polyhedra' per millilitre did not deteriorate on storage; refrigeration was necessary, but only to prevent the development of putrefactive bacteria.

The polyhedra of *Borrelina* are refractile, minute crystalline plates and are found in the body fluids of infected caterpillars. Although these polyhedra are not true virus particles, and are not themselves infective, the number of these platelets forms a convenient measure of the infective potentiality of virus preparations. Supplies of *Borrelina* virus were bred in the laboratory from infected caterpillars. On a larger scale, garden plots infested with *Colias* caterpillars were sprayed with virus suspensions, and in one instance where half a pint of suspension was used, enough dead larvae were collected a few days later to provide material sufficient for seven gallons of fresh suspension.

Use of fungi . . .

Deciduous woodlands are sometimes attacked by cockchafers, the adults feeding on the leaves while the grubs damage the roots of the trees. The adults, and, to a much less extent, the grubs are attacked by a fungus, *Beauvarla densa*. Of two common species, *Molontha melolontha* and *M. hippocastanel*, the former is the more resistant to this fungus, and in general, males succumb more readily than do females. The fungus fibres show first on the antennae, then appear at the limb joints and finally spread over the insect's body; after death the body dries out and the fungus spores it contains are infective to other chafers. Recent trials in Czechoslovakia have demonstrated the feasibility of artificially induced epidemics, for in one large wood, spore dust plus a powdered inert base broadcast at 40-50 kg./hectare gave excellent control of chafers; treated portions of woodland examined later, showed an average of two live and three dead grubs in plots of 10 square metres area, while untreated plots carried populations of more than 140 live larvae.

. . . and bacteria

At Moorestown, New Jersey, the U.S. Department of Agriculture maintains a laboratory devoted to the culturing of two species of bacteria. These microbes, *B. popillae* and *B. lentimorbus*, cause milky disease in the grubs of the Japanese bettle *Popilla japonica*; the larvae readily succumb to the disease but the adults are immune. The grubs of this gaudy little beetle are especially numerous in the eastern parts of the United States and the damage they do to lawns and golf courses is particularly severe in the areas around Chesapeke Bay and Long Island Sound.

While milky disease occurs naturally, U.S. entomologists have discovered that by spraying a suspension containing up to 2 lb. of bacterial spores per acre of grassland, better than 90% control of the larvae is obtained. Moreover, artificially infected land is secure for a number of seasons against fresh larval attacks. Dead larvae contribute towards the future immunity of previously infested land because each maggot when dead contains up to 2-3 billion bacterial spores; and since there may be up to half a million larvae per acre the infective potential of the land is very high.

In the ten years after 1939 the Moorestown laboratory has produced more than 145,000 lb. of spore material. Laboratory-reared grubs are inoculated with spore suspensions and then incubated for ten days at 87° F. At the end of incubation, most of the larvae are dead and the bodies are dried and pulverised; the powder is finally standardised to contain 100 million spores per gram, and it is this material which is used for the lawn treatments.

French work

A recent French publication gives details of natural control by microbes of insect pests in vineyards around Toulouse. Here a soil-living fungus, *Fusarium lateritium*, normally a saphrophyte, has become parasitic upon *Phylloxera* in the leaf galls of the vines. All stages of the insect are attacked and it has been estimated that 60% of the natural mortality amongst *Phylloxera* is due to the activity of this fungus.

Danger from fungicides

Recently there has been a report that fungicides used for the control of fruit diseases have lead to outbreaks of insects due to the death of their fungus parasites. Steinhaus, in his monograph, notes a claim that lime sulphur in American citrus

orchards has led to an increased infestation of various scale insects, an assertion never since confirmed. Moreover, Pickett has also claimed that the use of sulphur to control diseases of apples has resulted in increased numbers of oystershell scale and of European red mite. In one instance, also, it is believed that a sharp increase in codlin moth damage in an orchard was due to fungicides which had killed a fungus disease of the codlin larvae.

ALAN GOODMAN

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South Africa's Cotton Insect Problems

WRITING in the November 1950 issue of *Farming in South Africa*, Dr. T. J. Naude, Chief Entomologist of the Union's Department of Agriculture, warned cotton growers of the dangers of a sudden insect attack upon their crop. During the cotton boom of 1928-30 growers lost heavily, and many were ruined by the depredations of insects; now world prices for cotton are high and a new generation of farmers is planting increasingly greater acreages to cotton, but unless growers are prepared to deal with insect pests some men might go out of business.

Preparedness meant laying in stocks of insecticides, purchasing equipment to distribute the insect poisons and, above all, realising that control measures on a community basis might save them all a lot of money. Generally, spraying was to be preferred to dusting, but low pressure spraying gear was expensive and besides there might not be sufficient water available. Thus many farmers would be forced to use dusting equipment. In Dr. Naude's view, low volume spraying was not feasible under local conditions.

Many farmers would not have powered blowers and would use hand machines, but these were slow, prone to mechanical troubles and did not give an even coverage. During an insect attack time was the essence of success and it was unwise to rely on hand blowers; a battery of five of them could not be expected to treat more than 20 acres in a day.

Aeroplane dusting clearly was the answer. Several firms were prepared to undertake the work at 3s. an acre for flying costs alone, but if assured of large acreages to be treated on a community basis, contractors would be the more ready to cut flying charges to the minimum.

The Division of Entomology believed that about 15 lb. of dust would be necessary per acre, so that a DDT treatment against bollworms or Stainer should cost 7s. 6d. plus the flying cost. Thus large areas might be cheaply and quickly treated and an infestation swiftly brought under control.

The crucial months when treatments might be necessary were January to March, and during this time farmers were advised to make frequent inspections of their standing cotton. Aphids were a likely but unimportant pest and could be controlled with pyrethrum, nicotine or parathion; parathion is dangerous and should be used only by experienced operators.

Costs per acre for a single treatment with 10% toxaphene or 5% BHC should average at 20s. and 4s. respectively for control of bollworm and aphids. While against red spider 1% parathion dust or dynone, both at 20 lb. per acre, would cost approximately 15s. and 28s. 4d.

Seldom has a responsible public official uttered so many warnings against the use of modern synthetic insecticides as did Dr. Naude in his article. By destroying the parasites and predators, natural checks to the spread to insect pests, ' insecticides such as DDT, BHC and toxaphene are almost certain to change potential aphid infestations into serious actual infestations.' This warning was coupled with the assertion that ' DDT treatments (for bollworm) may be followed by more bollworms and by entirely new and heavy outbreaks of aphids and red spider.' Dr. Naude may have overstated his case against these insecticides but his opinion must not go unheeded by horticulturalists anywhere.

Biological Control of a Weed in Mauritius

IN the article by Mr. R. J. Lever in this issue on biological control mention is made of the control of weeds by means of introduced insects. A recent example of the successful control of a noxious weed by means of introduced insects which feed upon it comes from the British Colony of Mauritius.

The weed in question is *Cordia machrostachya*, locally known in Mauritius as *Herbe condé*; it is a native of the West Indies and South America, where it is known as ' Black Sage,' where, however, it is not a pest since it is there held in check by certain insects.

It was accidentally introduced into Mauritius about 1890 in a cane consignment from British Guiana. Fifteen years or so later the sugar-cane root grub, popularly known in Mauritius as Phytalus (*Clemora Smithi* Arrow), was introduced, also accidentally, from Barbados. Phytalus soon became a severe pest and caused immense damage to cane. Numerous insect parasites were introduced to keep Phytalus under control after an intensive campaign of hand collection of adult beetles had failed. It was then found that some of the introduced insect parasites of *Clemora* were particularly attracted by the sweet secretion of the vesicular hairs of *Herbe condé*. In consequence, the plant was planted alongside cane fields in areas infested by *Clemora* in order to help the parasites. In this way *herbe condé* was spread over a large area of the island. Birds, especially the Bul-Bul (*Pycnonotus jocosus*), also known as *oiseau condé*, did the rest. *Herbe condé* soon invaded all waste lands, open spaces, pasture lands, which had to be abandoned, and also fureraea plantations, causing an increase in the cost of production of fibre and an appreciable deterioration in their quality through the friction of the rough *Cordia* shoots on the leaves.

In view of the adverse effects on local agriculture brought about by *condé*, a scheme was prepared by the Department of Agriculture early in 1939 for an investigation into the insect fauna of the Caribbean region, *condé's* native habitat, with the object of introducing insect parasites of the plant into Mauritius. Owing to war conditions work proceeded slowly, a start being made in 1944 in Trinidad with the assistance of the Imperial College of Tropical Agriculture.

In 1945 Mr. P. O. Wiehe, plant pathologist of the Department of Agriculture, Mauritius, undertook on behalf of Government and of the Chamber of Agriculture, a study of ecological conditions affecting *Cordia macrostachya* in the West Indies with the object of formulating recommendations for the control of the plant in Mauritius.

Finally, various insect parasites were introduced, acclimatised and released. One of them, *Schematiza cordiae*, feeds voraciously on the leaves and young shoots of *Herbe condé* both in the larval and adult forms. It was received from Trinidad in 1947, was kept under observation in Mauritius and subjected to exhaustive feeding tests until 1948, when it was liberated. It has so vigorously attacked *condé* that, in the short space of two years, *condé* has ceased to be a problem. Its destruction in so short a time must be considered as an outstanding achievement in the field of research and as a real boon to Mauritian planters in general and to fibre producers in particular.

Factors Affecting Rice Production

The International Rice Commission of the Food and Agriculture Organisation of the United Nations is proving a very active body. At its first meeting in Bangkok, Thailand, in March 1949 it undertook to assemble material on the general conditions of rice production in various countries in order that India and perhaps other countries might make use of it to raise their average production. For this purpose the Commission prepared a questionnaire which was sent to the countries concerned. The replies to this have been reviewed by Mr. K. Ramiah, Director of the Central Rice Research Institute at Cuttack, Orissa, India, and have been incorporated in a mimeographed report by FAO, the summary of which we reproduce below.

Yields

THE large variations in yields in the different rice-growing countries of the world have been examined in relation to various factors like climate, soil cultivation practices, economic position of rice farmers, etc., in order to ascertain whether specific factors could account for the existing high or low yields.

Yields are definitely higher in sub-tropical regions than in the tropics, and variations within the tropics are small. It cannot be said that the particular climatic conditions of the sub-tropics alone are responsible for high yields since other favourable conditions such as better water supply, intensive manuring, rotations, etc., also exist there. It may, however, be said that mild temperatures, not less than 70° F. and long days with intensive sunshine during the growing season, such as are characteristic of the sub-tropics, favour the physiological activities of the plant. Within the tropics irrespective of temperature, rice grown in cloudless autumn or summer weather gives better yields than that grown in monsoonic cloudy weather. Under the latter conditions, manuring encourages higher vegetative development of the plant at the expense of the grain. Seasonal conditions also influence the response of varieties to manures.

Soils and water

While there are considerable variations in rice soils there is no doubt that rice prefers heavy soil. While the pH of rice soils varies from 4.5 to 8.7, better yields are obtained in neutral or acid soils than in alkaline soils. The extension of rice cultivation to whatever regions water is available, irrespective of soil conditions, appears to be one of the reasons for the low average yields in the tropics.

Adequate and timely supply of water has perhaps the largest influences on yield. While this supply is satisfactory in sub-tropical countries, this is not the case even in irrigated areas of the tropical countries. In the latter group, yields are always higher in irrigated areas than in purely rain-fed areas. There is no relation between rainfall and yields. In fact, the largest yields are obtained in areas with a moderate rainfall, not more than 20 to 30 in., but with good irrigation facilities. The most important requirement for increasing yields should therefore be the improvement of water supply.

Cultivating and manuring

Deep ploughing where the soil is worked dry and puddling the soil where the crop is transplanted, help in the control of weeds. In most tropical countries insufficient attention is given to the important operation of weeding.

There is no systematic practice of manuring rice fields in the majority of tropical countries. Only in recent years has the use of fertilisers for rice crops come into practice. It is clear from the information available that the best method of increasing yields in the tropics is to extend the practice of intensive manuring which should judiciously combine organic matter and an inorganic nitrogenous fertiliser such as ammonium sulphate. In some areas phosphates will be needed in addition to the above.

Varieties

It is recognised that improved varieties contribute to increased yields. In the sub-tropical countries the breeding of improved varieties and a wide distribution of them among the farmers go hand in hand, but in tropical countries, even where improved varieties are available, sufficient attention has not been given to their multiplication and distribution. In India, where breeding has been practised longer than in other tropical countries, seed distribution schemes have only recently been organised on a proper basis. It is said that nearly 50% of the rice area is covered by improved varieties in Madras State in India.

In connection with improved varieties it has not been sufficiently recognised that for best results they should be grown while also manuring the fields. This practice has received considerable attention in Japan, but tropical countries will have to give greater consideration to this question.

The data supplied on varieties indicate that while maximum yields are obtained from varieties with a five months' growing period, equally good yields can be obtained from varieties with a shorter growing period, provided the seasonal and other conditions are favourable. It is also found that higher yields are obtained from coarse or bold grained varieties than from fine varieties. Coarse varieties are hardy, respond better to manures, mill better and are more nutritious in processed form.

Interdependence of factors

The several factors affecting production are not independent. Intensive methods of cultivation, manuring, rotation and growing of improved varieties all depend for their success on adequate water supply. This correlation of factors should be taken into account in any effort designed to increase production. Only season and climate will remain as uncontrollable factors, but their limitations can be overcome in a certain measure by selecting suitable varieties for growing.

Economic problems

Economic problems such as the size of holdings, forms of tenure and credit facilities have been dealt with briefly, but it is evident that in any attempt to increase production the matter of credit must be given sufficient consideration. The village agricultural co-operatives which are said to be very successful in Japan, might repay a thorough study with a view to introducing them into certain tropical countries where holdings are very small, and rice farmers have insufficient resources of their own.

FARM MACHINERY

The new McCormick International No. 64 harvester thresher in action; it has a six-foot cutter bar

A Wood rotary cutter working on stubble, Johnson grass and weeds on an Oklahoma farm

American Rotary Cutter

A new rotary cutter is reported to have been gaining prominence on the American market during the past few years. Designed by Wood Bros. Mfg. Co. of Oregon, Ill., it is an all-purpose machine which shreds maize and cotton stalks, potato haulms, cover crops, and all straws and stubbles, including flax straws *in situ* on the ground. For pasture control it has been found that cut turf gives a richer and more even pasture for livestock. In clearing land, the cutters eliminate much of the arduous work of weed and brush control, at the same time providing soil-building residue, since materials shredded by the whirling blades are left on the ground.

Wood rotary cutters are also used in fruit-growing and vineyard districts, where they can shred prunings and mow cover crops between the trees and vines. Rubber and sugar cane planters are also using them with satisfactory results.

The cutters are manufactured in three sizes: Model 30A which shreds a 5-ft. swath, Model 50A which shreds a 6-ft. 8-in. swath, and the giant Model 60A with a cutting width of 9 ft. 6 in. Each model is equipped with a power take-off connection using needle-bearing universal joints which permit turning at any angle without knocking the joints.

The two sets of blades, available in suction or non-suction type, are made of alloy spring steel. There is a shear-bolt arrangement that protects blades and machine against damage from rough, uneven ground and all kinds of stones found in the average field.

Sale of the Wood rotary cutters is handled on a world-wide basis by the Geon International Corporation, 67 Broad Street, New York 4, N.Y., U.S.A., who, we are informed, will send complete literature and prices upon request.

New IH Combine

Straight-through design and balanced-flow movement are two features of a new 6-ft. McCormick International Harvester thresher, recently introduced by the International Harvester Export Company. The new No. 64 replaces two previous combines in the firm's line of grain-harvesting machines. In the No. 64 the crop moves in a straight uniform line from cutter bar to grain tank, the balanced-flow movement enabling any volume cut by the full 72-in. cutter bar to be handled without clogging. Adapted to combine successfully any of more than 100 seed crops as well as common grains, the No. 64 can be adjusted for a grain-saving job in either short or shoulder-high crops.

Features of the model include low-angle feeding, two-point separation, rub-out threshing, and double-action cleaning. Grain separation occurs first at the concave grate, and again on the straw rack, lessening the likelihood of carrying the grain over the straw. Double cleaning is provided by the chaffer sieve and extension and the cleaning shoe. The working parts that perform these and other functions are larger than those of other machines in the small combine class, enabling the machine to do work generally assigned to 12 ft. threshers. The No. 64 comes equipped with either engine or power take-off drive. Facilities for handling the grain include either a 25-bushel grain tank with auger unloader which unloads in less than one and a half minutes, or a bagging platform. A special pickup attachment for gathering crops which have been allowed to ripen in windows is also available.

Fineness Tester on a New Principle

An instrument which should be useful to manufacturers of insecticidal and fungicidal dusts and powders is the Vortex testing sieve, now being manufactured by Cornwall Mills Ltd., Par, Cornwall. It is possible with this machine to carry out fineness tests in the minimum time because the principle of this testing sieve is claimed

to eliminate all tapping, shaking and vibrating.

The V.T.S. consists mainly of a vortex chamber engaging with an air-tight seal upon a sieve frame into which latter part is placed the aggregate or powder to be tested. Ten gm. or c.c. is normally found to be a satisfactory amount for a test. These ten gm. must not be placed in the centre of the sieve cloth, but as near to the wall of the sieve frame as possible. This allows the air current to carry the powder into the vortex. The blower unit, when switched on, blows an air current into the vortex chamber, the ' throughs ' pass away to the dust collector, and when the action is complete the residue gives the weight result which is usually expressed as a percentage.

A time switch is fitted to the machine as a necessary component because the running time for a test has only a maximum period of about six minutes. The weight of the V.T.S. is approximately 37 lb., and the machine can be run off normal household grid electricity.

Combined Car and Tractor Introduced in Italy

It is well known that Italy, although primarily an agricultural country, has not mechanised her farms to the same extent as her neighbours. This fact is clearly shown by the statistics of tractors available in various European countries as shown in the table below.

	1 tractor for every—
Switzerland	23 hectares of land
England	31 ,, ,,
U.S.A.	47 ,, ,,
Sweden	133 ,, ,,
Holland	141 ,, ,,
Western Germany ..	153 ,, ,,
Belgium	200 ,, ,,
France	212 ,, ,,
Italy	238 ,, ,,

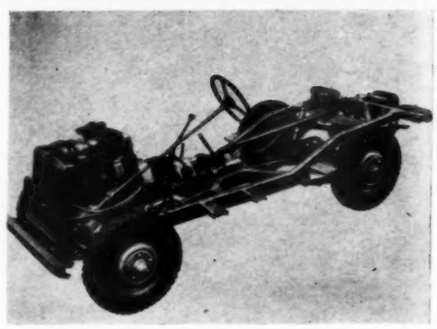
Moreover, the few tractors on Italian farms are for the most part obsolete. The principal reason for this state of affairs is that the many small farmers usually grow a little of everything and do not specialise in any one particular crop. The cost of a tractor and implements is well beyond the reach of most farmers—even those who are considered prosperous by their neighbours.

This problem has been studied by the agricultural machinery department of the Fiat factory, and at the Lavant Fair, held in Bari in September Fiat exhibited their solution to Italy's mechanisation problem in the shape of their new car, ' Campagnola '; an approximate translation of this word, incidentally, would be ' country lass ' or ' farmer's wife.' This machine is essentially an open model car seating six persons. It is equipped with a belt drive and drawbar, making it capable of acting as a power source for pulling farm implements or driving stationary machinery. Thus it is in this respect similar to a jeep or Land Rover.

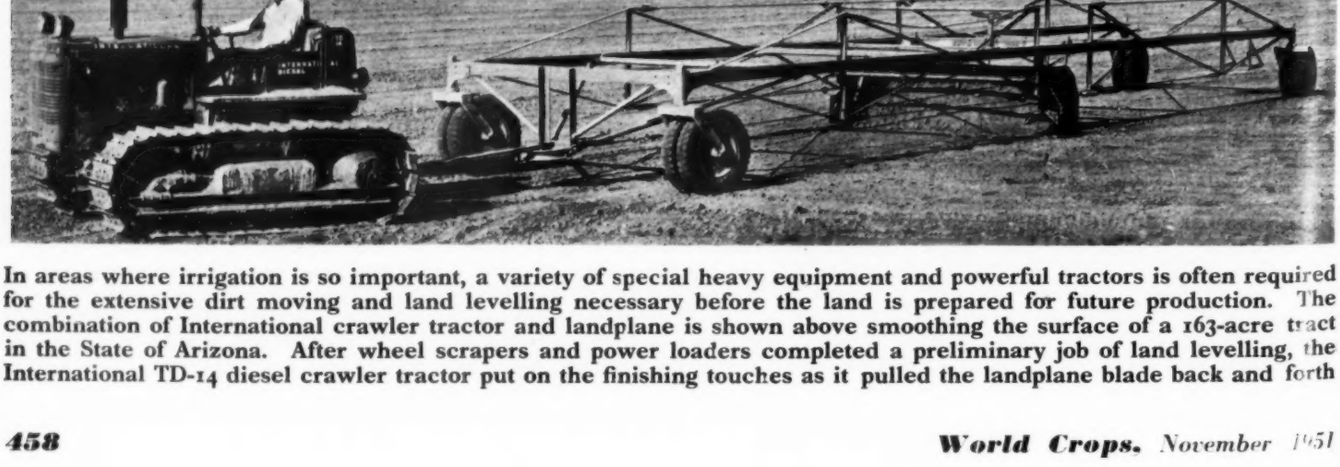
The important point is that it is a vehicle capable of carrying the farmer and his family anywhere on business or pleasure. Its carrying capacity is about half a ton; it is equipped with a four-wheel drive and is claimed to be capable of travelling across open country, *e.g.* moors, ploughed fields, gradients, rocky surfaces and not too deep rivers. It can climb a hill with a gradient of 40 deg. ' Campagnola ' is powered by a four-cylinder petrol engine developing 53 h.p. It has eight forward speeds and two reverse, its minimum speed being slightly over 5 m.p.h.

It will be interesting to see how this innovation to Italian agriculture is accepted by the farming communities during the next year or so.

The accompanying photographs, supplied by our Italian correspondent in Rome, show the ' Campagnola ' engaged in various jobs.



The all-purpose car ' Campagnola ' (*above*) shows its versatility; the chassis view exposes the four-cylinder 53 h.p. engine



In areas where irrigation is so important, a variety of special heavy equipment and powerful tractors is often required for the extensive dirt moving and land levelling necessary before the land is prepared for future production. The combination of International crawler tractor and landplane is shown above smoothing the surface of a 163-acre tract in the State of Arizona. After wheel scrapers and power loaders completed a preliminary job of land levelling, the International TD-14 diesel crawler tractor put on the finishing touches as it pulled the landplane blade back and forth

WORLD CROP REPORTS

ARGENTINA

Grain review.—Towards the end of September rains were urgently needed, especially in Northern Provinces and Western Buenos Aires, to avert serious crop damage. Province of Buenos Aires crops were generally considered to be in fairly good condition.

Trade circles give the following estimates of the areas sown to crops for 1951/52 season: Wheat, 4,000,000 hectares compared with official figure 5,535,000 hectares harvested 1950/51; oats, 550,000 against 635,000; barley, 700,000 against 585,000; rye, 500,000 against 709,000; and linseed, 500,000 hectares against 827,700 harvested last season.

Large 1950-51 tung crop.—The Argentine harvest of tung fruits in 1950-51 is estimated by trade sources at nearly 72,000 short tons, exceeding the previous record of approximately 66,000 tons in 1948-49. Crushing of the record crop began in July and will continue until next May or June. Production of oil, assuming an average extraction rate of 15·5%, will probably exceed 11,000 tons.

Exports of Argentine tung oil during the first half of 1951 were reported unofficially at 4,748 tons, of which 4,370 tons were destined for the United States. All such sales are made through the Argentine Trade Promotion Institute (IAPI).

CANADA

Good sugar prospects. — Canadian sugar beet acreage in 1951 is officially estimated at the near-record level of 101,200 acres, compared with the record 101,650 acres harvested in 1950. Although the official estimate for 1951 includes 1,000 acres in Alberta, abandoned as a result of bad weather, crop conditions in other areas have been such that total beet production for the current season is unofficially estimated at a million tons, compared with 1,128,000 tons harvested in 1950. If the sugar yield from the beet reaches the average of 14%, Canada's 1951 beet sugar production would total 150,000 short tons, raw value, an increase from the 145,000 short tons produced in 1950.

Potato acreage down. — The preliminary estimate of the 1951 Canadian potato acreage shows a reduction of 21% from the 1950 harvested figure. The total acreage this year is indicated at 400,900 acres compared with 505,200 acres in 1950. Plantings are down 25% in the Maritime Provinces (30% on Prince Edward Island), 21% in central Canada, and 15% in the western provinces.

Wheat prospects in the prairies.—The danger of frost for most of the prairie's crop is over, the Canadian Bureau of Statistics states in the last of a series of eight reports covering crop conditions throughout Canada. With warm, drier weather prevailing, harvesting operations were in full swing in the greater part of Manitoba and Alberta by the middle of September.

The bureau, in a previous report, estimated that Canada would harvest a record 579,000,000-bushel wheat crop this year.

HOLLAND

Maize increase.—The Dutch Government's efforts to promote maize growing in Holland have met with satisfactory results. This year, a total of about 11,300 hectares were sown to maize compared with 4,423 hectares in 1950 and 4,499 in 1949.

The Government gives financial support to maize-growing farmers, varying from 100 to 200 florins per hectare during the first year and from 50 to 100 florins during the second. Farmers undertake to cultivate a certain acreage of maize varying from 5 to 25 hectares.

ISRAEL

32% rise on field crops.—A total of 1,546 dunams (1 dunam = ¼ acre) of unirrigated field crops were grown last winter, a rise of 385,085 or 32% over the previous year.

Barley accounted for 612,357 dunams (38% of winter crops), a rise of 23% over 1949-50, wheat 407,661 (26%), an increase of 11% over the previous year; and fodder 344,736 dunams (22%), a rise of 57%.

The cultivation of fodder, grazing and green manure on irrigated lands increased from 38,840 dunams in the winter of 1949-50 to 50,215 dunams last winter, an increase of some 44%.

Achievements.—The area under cultivation by Jewish farmers has increased by nearly 1,500,000 dunams, rising to 2,200,000 in 1950, as compared with 1,600,000 dunams in 1949 and some 770,000 dunams at the end of 1946. It is estimated that the country's total agricultural output rose by 80%, almost equalling the growth of the population. In 1950 alone the physical volume of agricultural output increased by 25%. The total value of Jewish agricultural output for 1949/50 is estimated to have amounted to IL.43,700,000 as compared with IL.27,000,000 in 1947/48, an increase of 60% in the last two years. While the country is still dependent on imports for the supply of grain, oilseeds, meat, etc., it has almost reached self-sufficiency in dairy products and eggs, as well as vegetables and certain fruits. The number of Jewish agricultural settlements has nearly doubled, increasing from 274 at the end of 1946 to 537 in 1950. Moreover, it should be remembered that the country is on the threshold of a most important new phase of agricultural advance which is due to results from development projects now in the course of materialisation, *e.g.* vast irrigation schemes and drainage projects (the Huleh Valley).

BOLIVIA

New edible-oil plant.—An edible-oil factory near Cochabamba, Bolivia, has been opened. The plant already had been producing tinned edible oil from sunflower seed on a small scale, trial-run basis for several months.

The plant, named ' Fabrica de Aceites ' (Oil Factory), is reported to have a production capacity of 600 short tons of oil per year. Initial output will be limited to about 200 tons annually by the present level of Bolivian edible oilseed production. Efforts are under way, however, to increase domestic oilseed output to meet the factory's maximum capacity requirements of 3,300 tons. Feed cake, saleable to the Cochabamba dairy industry, will be a principal by-product with production eventually expected to amount to 1,100 tons. Planned expansion, if carried out, would result in production of vegetable shortening, soap, linseed oil and varnishes. Sunflower seed, groundnuts, and in smaller quantities linseed and cottonseed, are the raw materials expected to be used.

TURKEY

Encouraging cotton estimate.—The 1951-52 cotton crop is estimated at 827,000 bales (500 lb. gross), 47% above the 562,000 bales produced in 1950-51, and considerably above previous estimates of 700,000 bales for the current season's crop. If the 827,000-bale production is attained, the yield on the 1,350,000 acres planted to cotton would average almost 295 lb. of lint per acre. This compares with a three-year average yield of 244 lb. in the period 1948-49/1950-51 and 287 lb. in 1949-50, the highest of those same three years.

SOUTH AFRICA

Chicory exports. — Chicory, the Union's prettiest and probably least-known crop, reports our correspondent, has smashed all records this year and has given the Chicory Board its first export possibilities in history. This blue-flowering crop, grown only in the patch of coast on the Cape Eastern Province which enjoys rains all the year round, has surpassed all expectations owing to the long Eastern Province drought ending. The crop is expected to reach between 22,000,000 and 24,000,000 lb.—nearly three times the 1948 record of 8,400,000 lb. For the first time since the Chicory Board was founded a surplus of chicory over the country's normal requirements is expected.

A new record next year is quite unlikely. According to the Division of Economics and Markets, sowings for the new season have been below the level of previous years, and in particular well below that of last year.

The chicory growers were too busy trying to reap the enormous late 1950-51 crop of roots during the autumn, when the new crop should have been sown.

Reduced Natal sugar crop.—The good rains which fell recently in the Natal sugar belt were too late to save this year's crop. The prolonged drought, the worst recorded in 60 years, has reduced the crop on the north coast by 10-30%, and on the south coast, which is even worse hit, by 15-40%. Many of the mills, which normally crush until mid-December, expect to close in the first or second week of November. Mills report, too, that they are taking more cane per ton of sugar this year than normally and the juice is inferior.

Rice expansion anticipated.—Rice will be planted on an unprecedented scale in the Transvaal this spring, thanks to the import ban. Hundreds, possibly thousands, of farmers with irrigated lands in the Northern Transvaal and the Lowveld decided earlier this year to plant rice in the spring because last year's pioneers had secured up to 2s. 6d. per lb. The Minister of Economic Affairs' announcement that the price of rice in the husk (previously not controlled) will be fixed at 1s. per lb. was a blow to extravagant hopes. Reasonably efficient farmers, however, believe that the new price will still pay them handsomely, compared with vegetables, and are going ahead. An ex-Service settler in the Loskop irrigation scheme, Mr. A. Creighton, said that an efficient grower should reap from 20 to 40 bags to the morgen. At 1s. per lb. this meant a gross return of £200 to £400 per morgen, compared with £40 at the most of maize.

More cotton wanted.—The Union's cotton production must be increased eightfold in the next two years to satisfy the demand of the growing South African textile industry, said Mr. S. J. Naude, chairman of the Cotton and Tobacco Committee, at the Transvaal Agricultural Union congress in Pretoria.

Last summer's crop was expected to reach 15,000 bales of lint—almost three times as much as the year before. But the 18 mills needed 42,000 bales and by 1952-53 would need 120,000 bales.

AUSTRALIA

Falling wheat acreage.—Australian wheat acreages are falling at an alarming rate, reports our Australian correspondent, mainly because of the result of the phenomenal rise in the price of wool since 1948. A sharp decline in exports of wheat is imminent.

In each of the past two years wheat and flour exports have been worth £108 million to Australia. This year they may not reach £70 million, and if the present trend continues they may fall even more sharply next year. In 1947-48 some 14 million acres were planted, but in 1950-51 there was an acreage drop of 14%, with some areas showing a cut of at least 40%.

Home consumption of Australian wheat, however, is steadily rising, and the production drop is a serious threat to Australia's position on the world's wheat markets. Some 11 million acres sown this year will yield about 140 million bushels, but about 80 million bushels will be needed within Australia.

Australia is committed under the International Wheat Agreement to supply 87 million bushels during this and the next season, yet on current estimates she will have only about 60 million bushels available. This season commitments may be met by drawing on stocks; but next season's outlook is problematic, to say the least.

Record rice harvest anticipated.—Australia will, by all indications this season, have a bumper rice harvest, and average yields per acre are likely to be the best on record, with a return to the grower of £25 a ton for paddy.

Latest estimate of the harvest is 75,000 tons, which will equal the wartime record of 1943-44. But this season's crop will come from 2,200 fewer acres.

Average yield of rice in New South Wales since it was first planted as a crop has been 1.90 tons per acre, but this season it is expected to reach about 3.00 tons.

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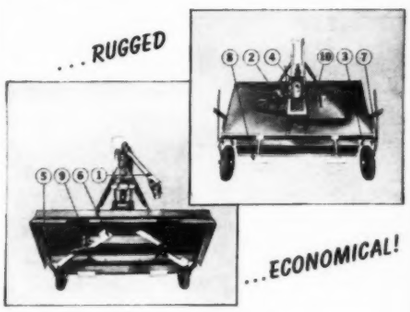

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